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A Call to Action—Steel Boom Menaces Cost and Even Actual Execution of Engineering Work

CIVIL engineers and contractors throughout the country have been watching the phenomenal advance in steel-mill activity without realizing that they are soon to be actors in the great drama and not merely spectators. The steel industry will in 1916 play a most important part in the cost and execution of all engineering work. Already prices have increased greatly. The trend is still sharply upward and the rounding of the curve is nowhere in sight. On the contrary, the awakening of the country's domestic business, coming at the same time as the large, and always increasing, volume of war orders, may send the market considerably higher. If the war should end quickly, the situation would change at once, but the safer course is to assume that hostilities are to continue.

Nor is the cost of next year's work alone at stake. The steel industry may determine whether work is to be done at all. The reason is on the surface. Already many mills are sold up to capacity for three or four months, while not a few are committed for their entire output until the second half of next year. That presages not only shortage of the actual steel materials entering into construction—such as shapes and reinforcing bars—but of plates, angles, rounds and other products essential to the manufacture of contractors' equipment. Already one manufacturer reports that the best delivery he can get on rounds for car axles is three months, while fifteen to twenty weeks is the quoted delivery on other finished steel products. Fortunately, equipment and machinery manufacturers are fairly well stocked, but the fabricated and partly fabricated equipment in hand was probably never lower. The first spring rush will consume the supplies now awaiting fabrication, and then will come delays that may be serious enough to cause the postponement of many an important and pressing job.

In the structural field reports from Pittsburgh show that the fabricating shops, too, have felt the pressure, due, of course, largely to the domestic revival. Practically all of them are filled up for the next four to six months, except as to heavy shapes. Some relief is possible from increases in capacity, but this is not expected to make any material difference.

It is the engineer's turn to think fast. The first man to let contracts for next year's work will be the most certain to have them executed and will get the lowest prices. In November many bond issues were voted. There should not be an instant's delay in starting the machinery moving toward the closing of the contracts.

The contractor no less than the engineer needs to understand the gravity of the situation. He would best be in close touch with the equipment manufacturers. He is not likely to commit himself for a new plant until contracts are in hand, but when time for action comes he must know where he can get what he needs, and how soon.

The manufacturers are fully awake to the conditions. They are doing all they can to secure adequate stocks of steel, but belated orders for equipment are almost certain to be accepted only on long delivery terms or to be refused. Then, too, the prices on them will necessarily be higher than for early purchases, though higher price levels must be expected even for the first deliveries.

This is not a time for speculation or procrastination. Where work is authorized, engineers owe it to their clients, municipalities, companies, to let the work just as soon as possible. Where work is imperative, but plans are not yet made or authority secured, the necessary machinery must be started at once. The penalty for delay promises to be severe.

Prosperity

WAR orders have received all of the credit until recently for the very great activity in American industry. It is being appreciated now, however, that there is a general business awakening. Fundamental conditions are excellent. The value of this year's crops over those of last year is over half a billion dollars. This is a pretty good basis for optimism. Railroad earnings are up and the carriers, long out of the market for equipment and renewal supplies, are spending more than they have for a couple of years. Inquiries made of this journal indicate that a busy year can be expected in 1916 in municipal and public engineering activities. The situation will be affected, of course, by the higher prices which supplies will command, and by the likelihood of a labor shortage. The general prosperity, however, will not be much affected. An early close of the war will have the effect of putting a brake on industry, yet many war orders have been taken on the basis of completing delivery, no matter when peace is declared. Industries, too, are preparing themselves as best they can for the reaction which peace must to some extent bring. Altogether, however, the outlook for 1916 is most encouraging.

Strong Local Societies

LAST week the Engineering Record had the pleasure of chronicling the great achievement of the Engineers' Club of Philadelphia in quadrupling its membership in a week's time. This week it presents some striking paragraphs from an address delivered by A. J. Himes before the Cleveland Engineering Society. Mr. Himes has made a strong point: that the strengthening of local societies adds to the influence and membership of national organizations. The strength of an association, a company or a nation is predicated upon the strength and unified action of individuals. Affiliation of the local branches of national societies is a necessary step if the profession is to win a larger place in the nation's life. The way to success in such affiliation has been partially pointed out by the successes in Boston, Philadelphia and St. Louis. The movement should—and must—become general. With the enthusiasm being shown in local organizations at the present time rapid extension of the idea is to be expected within the next year. Mr. Himes has stated the points well. His words deserve the thoughtful consideration of engineers individually, of local bodies and national organizations.

City Manager and Publicity

IF the city-manager form of government is to endure it must develop new means for diffusing knowledge of public activities. As a large portion of these are of an engineering nature, engineers will be called on to supply the necessary information. Those at the head of the movement already see the necessity for some more effective agency than has yet been tried to educate the public to a proper appreciation of what the new form of government is doing for the individual and for the city. The more efficient the government becomes the less impersonal and "colder" it gets. Moreover, the concentration of authority and responsibility in one person focuses on him all the complaints and criticism. No man or no system can stand up against the storm. Safety lies only in dispelling the clouds of ignorance by educational methods. Engineering facts and budget figures, however, do not make newspaper stories unless the engineer takes pains to point out the head line around which the "story" can be written. Good continuous publicity probably cannot be obtained by every engineer, and certainly not without cost. It requires special talent and aptitude—for which there is always a ready market. Someone must be found with engineering knowledge and with newspaper training to put flesh on the bare bones of engineering facts. It can be done, but the price is not low.

The War and Record Covers

FOR many years a striking red cover has been intimately associated with the Engineering Record. In fact, the phrase "Record Red" expresses to engineers and contractors widely the distinctive shade that the journal has made familiar by its weekly visitation. Now, however, the war threatens to endanger the continuance of this distinctive mark. The impossibility of securing dyes from Germany has resulted in the exhaustion of the particular aniline product used by the paper manufacturers in coating the stock for the Engineering Record covers. A number of mills have been experimenting with substitute products for some time in an endeavor to duplicate or approximate "Record Red." The experiments have proved unsuccessful. A limited supply of red ink is still obtainable, and beginning with the last issue double printing was resorted to. It will be noted that the inside of the covers is now white. How long the supply of red ink will last is problematical, but it is not unlikely that there will be some change in the color scheme.

It is worth mentioning for the information of those who have not followed the aniline situation, that the color supply generally, or such of it as depends on an aniline base, is very low. Manufacturers of clothing have been feeling the pinch for some time; and fast blacks and fast blues in wearing apparel of all sorts, if the war continues, will probably disappear entirely within six months. Not only will the Engineering Record, then, have to change its dress, but all of us may have to resort to lighter colored clothing than past convention has looked upon with approval.

Paving Repairs Over Water-Main Trenches

ALLOWANCES for payment for paving repairs over water-main trenches as made by many municipalities to arbitrary limits regardless of subsurface conditions encountered, are in large part responsible for the poor condition of some city pavements. In one very large city, for instance, payment is made for paving to one foot on each side of the interior diameter of the pipe. In the case of pipe under 12 in. in diameter, under average conditions, such payment is adequate. In the case of a 12-in. pipe it is liberal. In the case of a 20-in. pipe it is deplorable, and in the case of a 48-in. pipe it is absurd.

A contractor laying a 6-in. pipe in sheet asphalt would cut probably 18 in. of paving. This would give him ample room for laying the pipe and calking the joints. The paving company would demand 6 in. additional width for trim. This would give him a 6-in. overpayment under perfect conditions which would make up for greater widths he would be compelled to pay for at worse spots. A 12-in. pipe can be handily laid and calked in a 20-in. trench. This gives the contractor almost a foot of extra allowance.

A 20-in. pipe, however, requires at least a 26-in. width of trench, with bell holes every 12 ft., for this pipe is too large for one calker to get his arms around; he has to "buddy" with another. When all cuttings are taken into account it will be found that there is practically no allowance for "bad going" or wash-outs due to storm. A little loose material, such as is encountered in a filled street, or a little undermining due to water entering an unfilled trench, will be sure to make the contractor's paving bill exceed his payments for that item.

A 48-in. pipe would give him a 6-ft. width allowance. It might be possible for him to get his pipe down and calked in a 5-ft. cut and bell holes, but there would be delay in lowering almost every pipe and the operation would be costly. The logical width for such a cut would be about 5½ ft. Taking into consideration the allowance for trim, it is evident that he is skinning the very edge of his allowance. But, sufficient though this would seem, there is a still greater objection to holding the contractor down to such a width. A pipe of this size will ordinarily require a depth of trench of 8½ ft. When the pipe is laid the backfill must follow. Specifications are very rigid as to the proportion of tampers to shovelers. But, rigid as they are, they connot make it possible for the fill under the middle of the pipe to get much more than an accidental blow at infrequent intervals. The bulge of the pipe, reaching to a distance little more than ½ ft. away from the side of the trench only 2½ ft. from the bottom makes it impossible for the tamper to get his iron in. The result is a soft spot, which later leaves a void, and causes settlement of the pavement.

This method of paying for pavement restored over water-main trenches is not only inadequate, but illogical. It contributes very largely to the percentage of holes in the city's pavements and encourages undermining, the sly placing of a prop under a slab of paralleling pavement that has cracked some distance away from the cut and a trust-to-luck attitude on the part of the contractor that is harmful both to him and to the work.

It would be better for the municipality to take care of the paving restoration itself, or by a contract apart from that for the pipe laying. Allowable widths of trench could be determined in the field, after the subsurface conditions were revealed. The contractor could be rewarded by a bonus for every yard he saved within such limits and penalized for every yard by which he exceeded them. There may be methods better than this, but this is certain, that the present method of paying to arbitrary lines without regard to actual subsurface conditions is costly to both the city and the contractor.

Shall the Irrigation Settlers Be Given Relief?

ELSEWHERE in this issue is a letter regarding the Engineering Record's position on the present status of the United States Reclamation Service. The views expressed by the correspondent (a water user, known to the Engineering Record, who conceals his identity lest he be accused of toadying to the present administration of the Reclamation Service) are in opposition to those held by this journal. He represents what probably is the prevailing opinion in the arid West and, therefore, deserves careful consideration. Yet it must not be forgotten that the water users are parties in interest and that their views on that account may justly be suspected of being prejudiced.

Since the editorial of July 31, on the "Changed Reclamation Service" was written, the Engineering Record has secured further information—partly by personal contact with men in the irrigated sections—and has no reason for altering the views already expressed. It admits, however, to a deeper sympathy with those—and their number is few—who have located on holdings that could not under any circumstances be made a success.

Recently it has been proposed that further measures of relief—in addition to the 20-year extension law passed by the last Congress—be given the settlers. Some advocate a further extension of payment, others that loans (rural credit) be granted the water users, and others that the cost of construction chargeable to the irrigated lands be considerably reduced. It is quite likely that some of these remedies may be proposed in Congress in the near future, and a discussion of the situation is therefore timely.

THE CAUSES

It has been maintained by this journal that the irrigation troubles are due to the inexperience of the settlers in irrigation farming, to lack of capital and of the pioneer spirit. Regarding inexperience, there is no dispute. Even the West admits it. Again, as to lack of capital, there is but little argument, although it is contended that conditions should have been made such that the poor could have succeeded. The point recurs later in this argument and will be passed over here.

The lack of the pioneering spirit is apparent in many of the irrigators. Confident that irrigation farming was a get-rich-quick scheme that could not fail, they were unprepared mentally for wresting a living from the forbidden lands, for pushing back the borders of the desert, for raising a community from a barren waste. In all time, this has been the work of those who expected hardship and loved it. They may have been spurred on by the hope of getting rich quick, but at least they harbored no delusion that the road was an easy one.

As a result of the mental attitude one could have predicted the outcome—some dissatisfied men, some chronic complainants and agitators.

But are there not hard-working, deserving men who have failed utterly? Undoubtedly—and many of that class have still a hard struggle ahead. The trouble in these cases is generally lack of capital; and indirectly the agitators blame the Government for the shortcomings, financially and in ability, of its citizens. They say that the irrigation projects should have been planned so that a man with small capital could have succeeded. Yet everywhere in the irrigated sections are farms side by side where one man starting with ample capital has lost it all, and his neighbor, beginning with a thousand dollars or less, is to-day a prosperous farmer, or at least clearly sees his salvation ahead. The human element and not capital is the all-important factor. Yet little or no reference is made to it in the West, and nowhere, except from one or two of the strongest men, does one get the radical but businesslike suggestion that the Government be allowed to choose its settlers, to refuse to take those who seem foredoomed to failure.

Venture Unbusinesslike

What is very apparent is that the Government's venture has been very unbusinesslike. It has gone on the assumption that the sum of its duty was to provide the engineering structures for the storage, diversion, distribution and control of the water. This is but one element in successful irrigation. A soil agriculturally good, land leveled and drained, farms well stocked and equipped, crops adapted to the climate, farming methods suitable to the country and to the crops, competent irrigators, and last, but by no means least, good markets and marketing are needed. Theoretically, one would think that a business organization would have investigated every angle of the situation, would have weighed each factor and would have proceeded on strictly business lines. But this is theory. Experience shows that business has fared no better than the Government. Scattered over the West are the wrecks and partial successes of private projects. In fact, the really successful private projects can probably be numbered on the fingers of one hand. Where private capital has so strikingly erred, shall the Government be taken to task?

Unfortunately both the Government and the private interests seem to have regarded irrigation as they would a manufactured product, to be finished in a brief time and then turned off to the purchaser without a further thought from the creator. Irrigation work, however, is a development, a growth. Fifteen years is a minimum for its swaddling age. All parties have failed to realize this, and disaster, at least when measured by the rosy hopes of 10 years ago, has been the result.

But we have learned much. Without a doubt Government projects, if started to-day, would be handled differently. The Government (and private irrigation companies, too) sold the settler a factory unequipped, and the settler was unable to furnish the machinery, or only at a very slow rate. Consequently, there has been overhead but no income. Theoretically, it would have been better to have doubled or trebled the investment, so that there might have been an opportunity to get back the carrying charges and make a profit. The State of Victoria, Australia and the Canadian Pacific Railway have so argued. They level the land, build a house and necessary barns, and provide even the stock and equipment. The settler has a fully equipped factory when he moves on the place. He is ready to start earning at once. There is hope in such a program. The settler has not a five-year fight with nature and his unequipped factory ahead. But note, too, that Victoria and the Canadian Pacific pick their settlers, refusing to sell to those who do not promise well.

Something for Nothing

It is argued in the West that if Victoria and the Canadian Pacific are doing this that the Government of the United States should do likewise. But there is a great difference. In Victoria and in Canada the settlers know that they cannot escape paying for what they get and that meanwhile they must meet the interest on the unpaid balance. On our projects, encouraged by agitators and politicians, the settlers hope to escape a large part of the cost and to unload it on the general treasury of the United States. In fact, many water users predict that if they fight long enough they will have nothing to pay. And in this they are making progress. While presumably they are still to repay the cost in 20 years (instead of in 10, as under the original act), actually they pay interest on the Government's investment for 20 years and then get the works free. They are hoping, too, that the cost-review boards now reporting will help in the process of unloading part of the cost on the Government. The hearings before some of the boards have been disgraceful contests, in which counsel (without a regard for the intent of the Reclamation Act and the compact between the settler and the Government) aided and abetted by inexperienced engineers, have tried to discredit every feature of the projects and to have millions written off. These millions written off, of course, would become a gift from the country at large to the individual settler.

Under these circumstances how can one recommend the Victorian system for this country? It would give the agitator and the politician a still greater stake to play for. Particularly would such a plan be undesirable in this country, where the public would probably not be willing to allow the Reclamation Service to pick its settlers in accordance with their competence.

On one point, though, the Engineering Record agrees with the contention of the water users, that the leveling of the land should be done—or rather should have been done—by the Reclamation Service. This is a very heavy expense and is one of the principal factors in preventing the land from quickly being placed in cultivation.

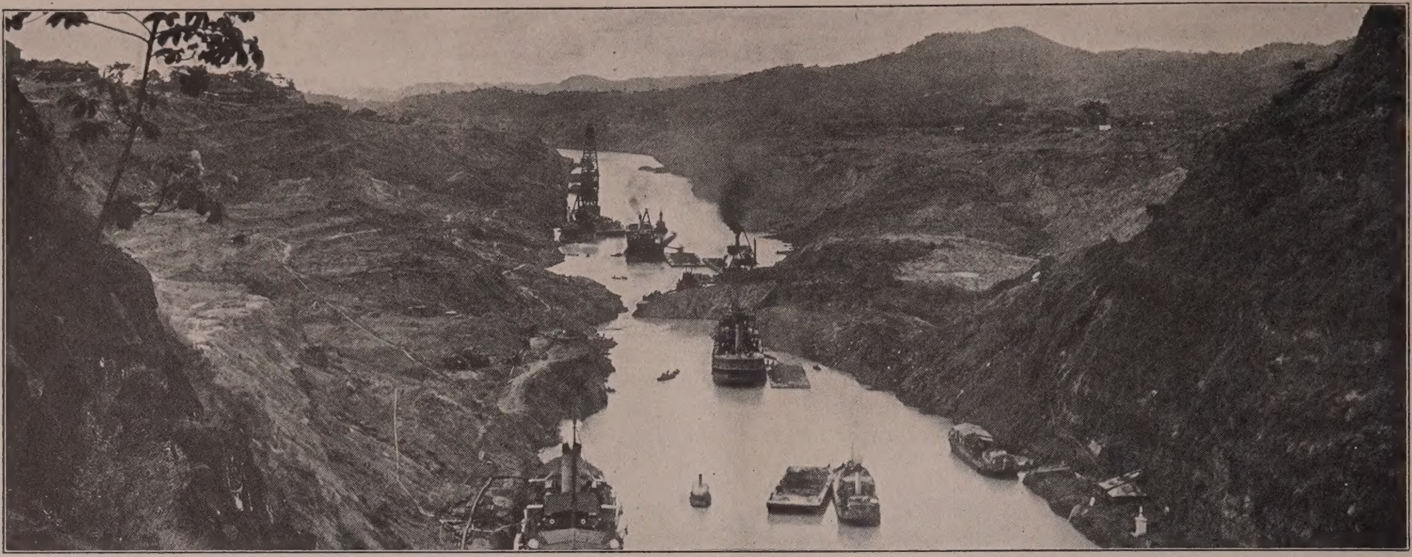
Relief and Loans

The pertinent question, of course, is what shall be done for the relief of settlers on existing projects. The observation of the Engineering Record indicates that the earnest workers, those who intended to farm their holdings and were competent to do so, are working out satisfactorily. Many of them have had a severe struggle; others are not through yet. The desirable element, by and large, however, is not discouraged, and believes that the dawning day is not far off. In cases where land obviously impossible to cultivate, on account of seepage or other adverse conditions, has been taken, the settler must be moved to holdings where it is possible for him to make a living and work out his salvation. In some of these cases, probably, the settler has lost much. This is unfortunate, but it is impossible to see how any relief can be given. Both the Government and the settler were in good faith. Someone's judgment was wrong.

As to a scheme of farm loans to irrigation settlers, the Engineering Record is very strongly against it if it is to be administered by the Reclamation Service. The settlers have been brought to believe that what they get from the Government through the Reclamation Service can by suitable agitation be gotten for nothing or for less than value. There would be grave danger, if farm loans were made, that there would be an effort to have them repudiated. The Engineering Record is not opposed to the principle of rural credits, but it holds that the management of a rural-credit system must not be in the hands of the Reclamation Service, but in a banking department of the Government. Then the water users would realize that they were dealing with a bank and would have to meet principal and interest in full. To grant such loans through the Reclamation Service would only result in new attempts to get something for nothing from the Government.

Finally, as to the doubts expressed by this journal regarding the future of the Reclamation Service under the present management, a bigger question mark must be written to-day than on July 31. Then the Engineering Record expressed doubts merely, and emphasized the view that the plan was not necessarily an impossible one. Matters, however, seem to have gone from bad to worse, and one must wait longer before passing judgment on the situation growing out of the establishment of the Denver office.

The Engineering Record cannot follow the urging of its correspondent to support the present administration. In fact, this journal would not be surprised if the Secretary himself were losing faith to some extent in the Lane policy. If he read the records of the hearings of some of the review boards he will be disgusted by the recital, by the spectacle of men trying to repudiate their obligations to the Government. Such a reading will likely make him question the advisability of still further softening the terms under which the irrigationists are working.



MATERIAL FORCED INTO CANAL FROM EAST SIDE OF CUT IS BEING REMOVED BY DREDGES

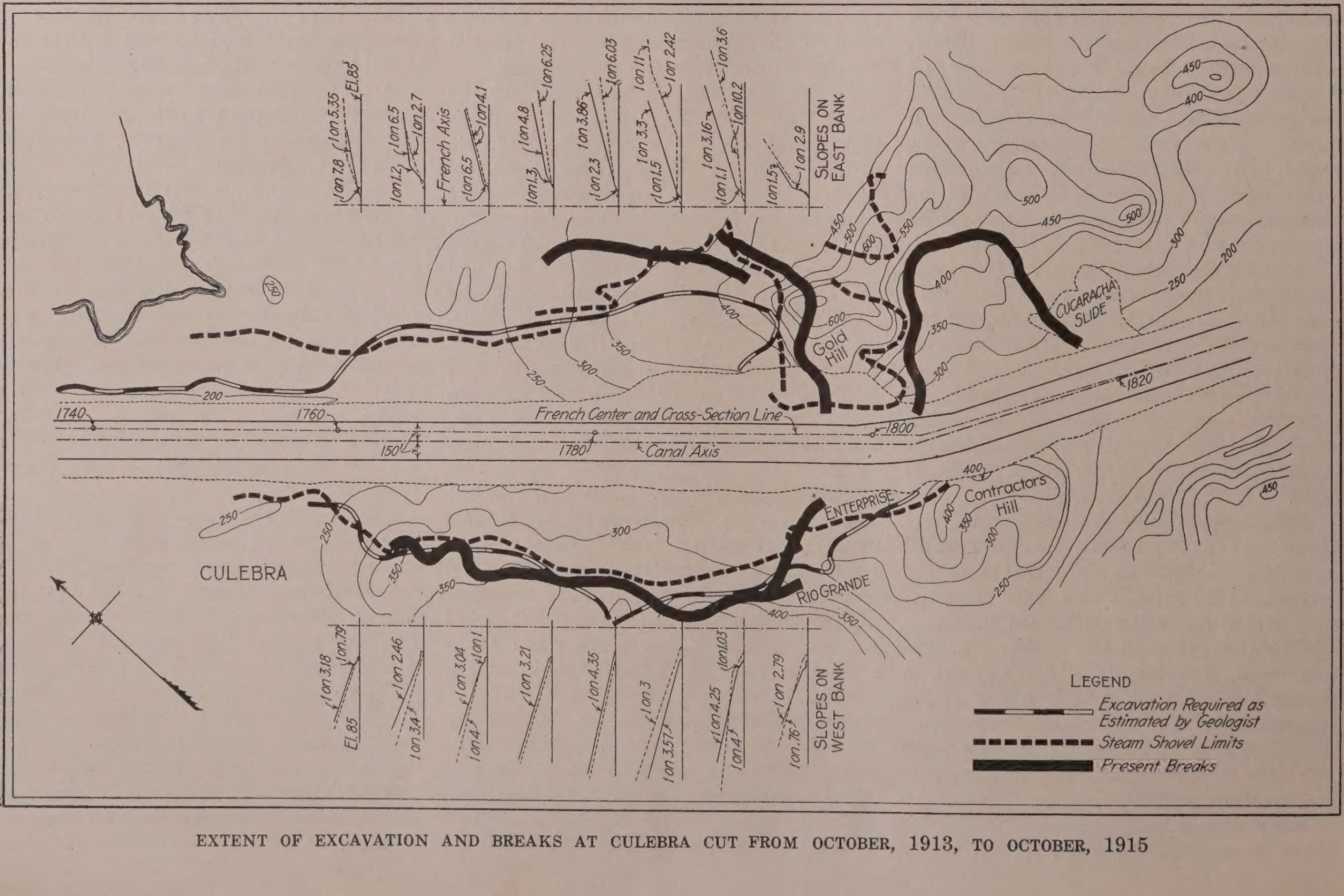
Ten Million Yards of Material Must Be Removed to Stop Panama Canal Slides

General Goethals, in Report to Secretary Garrison, States That, by Rushing Work on Ship Channel, Canal Need Not Remain Closed Until Dredges Have Excavated All Material—Complete History of Slides Outlined

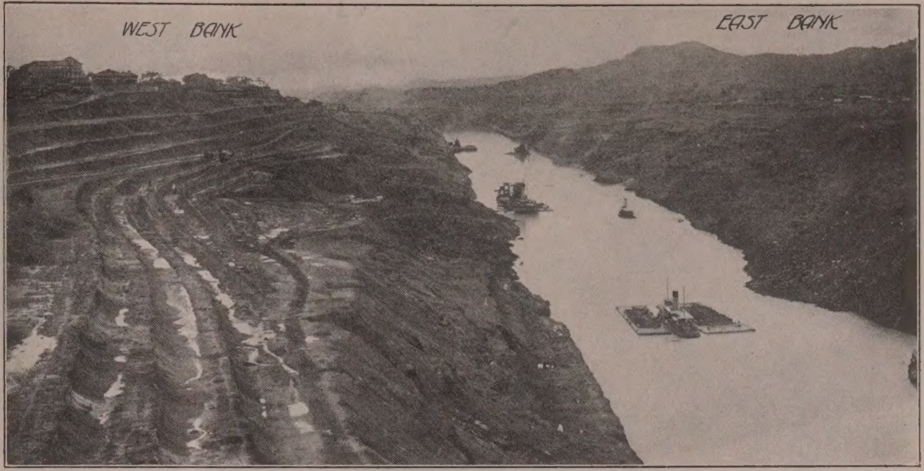
ALTHOUGH he estimates that 10,000,000 cu. yd. of material must be removed before slides at the Panama Canal will be permanently checked, Gen. George W. Goethals, in an exhaustive report submitted to Secretary of War Garrison Oct. 26, lays emphasis on the fact that the canal will not be closed to navigation during the entire period this work is in progress. All efforts are now being directed toward opening up a ship channel wider than the full prism width and dredges are now at work handling nearly 1,000,000 cu. yd. of material a month. On Oct. 6 the length of channel blocked was 1300 ft., and was reduced to 700 ft. at the time General Goethals made his report. Continued movement of the material, however, has made it impossible to break through the closure in the vicinity of Sta. 1787, which is now about 100 ft. in length. By permission of the Secretary of War General Goethals' report is printed below in full:

FULL TEXT OF GOETHALS' REPORT

The following report is submitted on the slides which have closed the canal to navi-



EXTENT OF EXCAVATION AND BREAKS AT CULEBRA CUT FROM OCTOBER, 1913, TO OCTOBER, 1915



BENCHES WERE EXCAVATED ON EAST AND WEST BANKS AT CULEBRA IN 1913

gation. On account of the importance of the subject, I deem it advisable to make a comprehensive report, even at the expense of repetition of the matter contained in previous documents on the subject.

The slides which developed during the construction period were of three distinct types. The first were due to the moving of material from the sides of the prism or cutting, when these were left by the excavation at a steeper slope than that at which the material would remain at rest.

In those of the second type porous material mixed with clay, small rock and spalls, overlaid smooth surfaces of rock or other impermeable substances, harder than the overlying mass, which sloped toward the axis of the canal. In excavating the prism through these sections the removal of the lateral support, combined with the effects of the water permeating through to the underlying inclined strata, resulted in the sliding of the material into the excavated area, the rains assisting and accelerating the movement.

The slides of the third class were designated "breaks," and were of two kinds, best described by the localities—those in the vicinity of Culebra and those at or near La Pita Point. In the former the first manifestation was a crack in the surface of the ground, generally parallel to the axis of the canal, with the ends running to the edge of the prism. This cracking was followed by a depression on the side of the crack away from the cut, and a movement of the mass between the crack and the canal into the excavated area. The sinking movement on the top was accompanied by an upheaving of the bottom of the prism. The cause of these movements was attributed to the poor quality of the underlying rock, which was intersected by vertical seams or seams sloping toward the canal. As the material was excavated not only was the lateral support removed, but the load distribution was changed to an extent that caused the rupture of the underlying weaker strata. After the break the movement into the cut was like an ordinary slide of the first and second classes, though the cause was entirely different.

The breaks in the vicinity of La Pita Point consisted of the moving or pushing out and a subsequent settling down of sections of rock masses which formed the banks; three such breaks occurred and were due undoubtedly to water pressure from the Obispo or East Diversion channel. This source of trouble has been relieved by turning the waters of the channel into the cut.

The first class of slides gave but relatively little trouble, even during the construction period, and ceased when the material assumed its natural slope. In anticipation of other possible movements of this kind, slopes which seemed too steep have been flattened by use of an hydraulic grader and by starting vegetation where the soil warranted.

CUCARACHA SLIDE CAUSES TROUBLE

Considerable difficulty was experienced with slides of the second class, and the most notable example was the one at Cucaracha, just south of Gold Hill. The only method of handling them was to allow the material to enter the prism and remove it from below, for the adjacent ground did not lend itself to handling the material in any other way ,and attempts to hold the banks by piling, rock covering, or drainage, failed. The slide of this class at Cucaracha consisted of clay mixed with rock and rock spalls moving into the cut, the movement resembling the action of a glacier.

The sliding began during the operations of the French company, and continued to cause trouble until the early part of 1912, when it became quiescent. The material in moving left exposed a mass of rock which the geologist assured us was of ample strength to hold back the clay and other material remaining on the hillside above it. The indications were that the future trouble in this locality would be limited in extent, and caused by small masses of clay washed down by rains or from the usual erosive action to be anticipated in this climate.

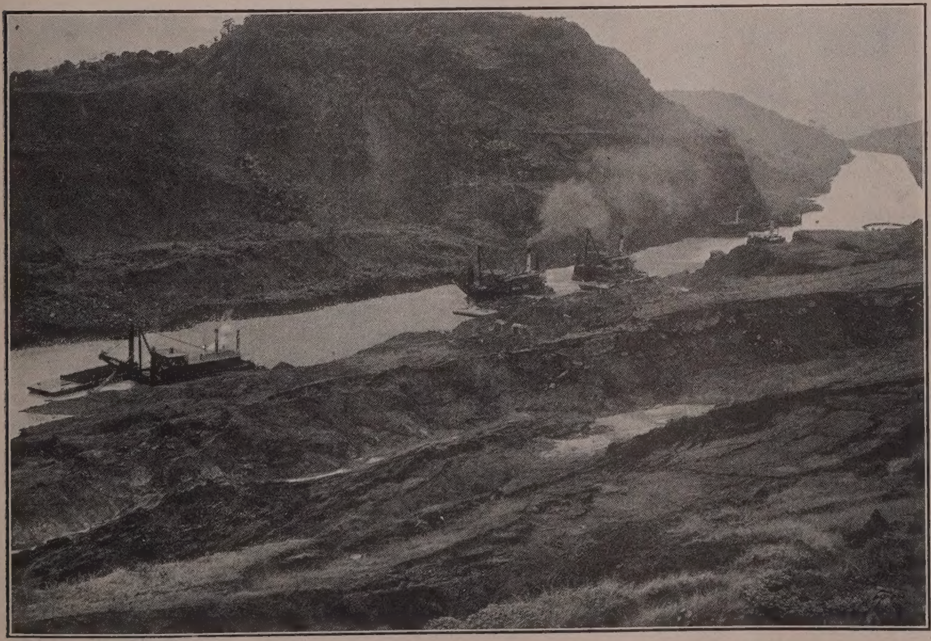
These expectations and predictions were not realized, however, for on Jan. 20, 1913, following a few days after a rock movement from the south face of Gold Hill, the rock support broke at some part of its structure near or below the bottom level of the canal, and a mass of clay and rock moved into the cut, completely filling the prism across its entire width and up to a bench that existed along the west face at the 69-ft. level.

The length of the canal blocked by this earth movement was approximately 1600 ft., and the quantity of material to be removed was estimated at 2,000,000 cu. yd. The slide was attacked by steam shovels located on the 69-ft. level on the west side and on the bottom of the 40-ft. level. As the excavation proceeded the material broke away from the higher elevations on the face of the hillside and moved down into the prism.

RELIEVE PRESSURE BY SLUICING

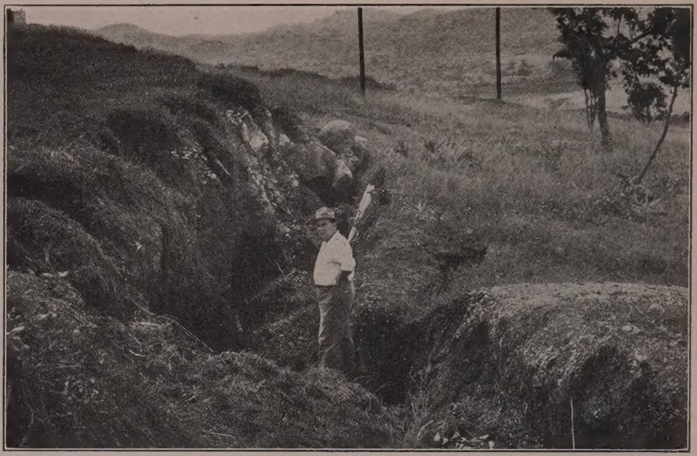
An examination of the top of the hill indicated that there were large masses of clayey material remaining that would eventually move into the cut. The topography of the country lent itself admirably to sluicing operations, by which a large part of the material near the top could be washed into a valley to the east. A sluicing plant was available, and steps were taken to draw off to the east side of the ridge as much of the clay as could be reached by the nozzles of the sluicing plant, and thus relieve the situation in the prism itself. This was successfully accomplished.

The balance of the cut, about 8½ miles, was nearing completion; steam shovels were concentrated at Cucaracha slide and as many were worked as available space permitted. In February eight of them removed 168,677 cu. yd.; six shovels working in March and April removed 203,030 and 204,308 cu. yd., respectively, but these were dry season months. The rainy season reduced the output of the six shovels in May to 148,000 cu. yd. and in June to 124,844



MOVING MASSES OF EARTH FORMED WAVES AT SURFACE

BROKEN-UP CONDITION OF MASS OF SLIDES PRECLUDES USE OF STEAM SHOVELS



HOW THE WEST BANK OF THE CANAL CRACKED DURING MONTH OF JUNE, 1915

cu. yd. The expectation of reaching the bottom at this time had not been realized. Difficulty was experienced in maintaining tracks, not only at the slide but on the dumps, due to the character of the material that was handled. The cost of removing 921,000 and 808,000 cu. yd. during the last two months, respectively, from the entire length of the cut, including Cucaracha, was 62 and 66 cents per cubic yard, respectively. With Cucaracha alone remaining the difficulties and cost would be increased.

There was a dredging fleet available capable of handling larger quantities of material than the shovels; the dredges could work 24 hr. a day, while the shovels could not work to exceed 12 hr.; the excavation could proceed without delays due to upset of steam shovels and disarrangement of tracks, and the material could be dumped in the Gatun Lake. Thus all indications pointed to dredging as the best means, both as to time and money, for the removal of the remaining obstruction. This course was taken.

The steam shovels operating at Cucaracha slide from Jan. 20 to Sept. 11, 1913, removed a total of 1,139,708 cu. yd., or an average of 142,463.4 cu. yd. per month. The dredging operations began on Oct. 23, 1913, and up to Aug. 3, 1914, on which date the first boat went through the canal, the dredges removed 2,767,080 cu. yd., or an average of 286,239.78 cu. yd. per month. The cost of the steam shovel work at Cucaracha was not separated from the remainder of the work in the cut, but the total of 8,225,989 cu. yd. removed during the period under consideration was done at an average cost of 65 cents per cubic yard, while the cost of the dredging averaged 44 cents per cubic yard. Active operations at Cucaracha slide ceased on Oct. 14, 1914, on which date the total amount removed by steam shovels and dredges since Jan. 20, 1913, was 4,679,238 cu yd. In addition, more than 1,000,000 cu. yd., which would have gone into the cut, were removed by sluicing operations at a cost of 20 cents per cubic yard.

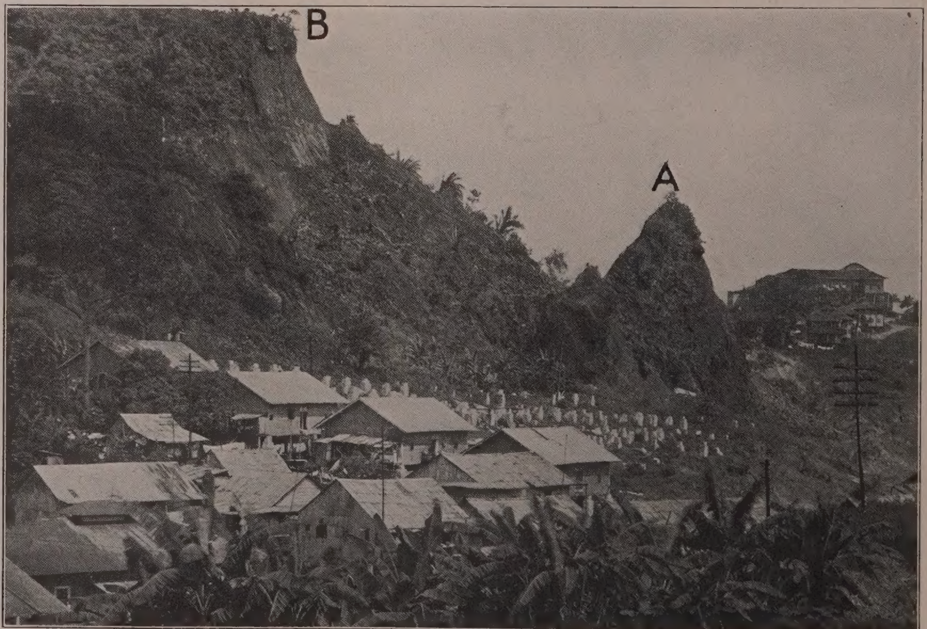
BREAKS AT CULEBRA

The first break in the vicinity of Culebra occurred near the old Panama Railroad station in 1907, and affected but a few hundred feet. Subsequently, as the depth of the excavation increased, the breaks became more extensive, both in length and quantities of material involved. Furthermore, they occurred in both the east and west banks, until the upward movement along the bottom of the excavated area affected a length of 2000 ft. north of Gold Hill. As the cause was the unequal distribution of the pressure exerted by the adjacent banks it followed that by reducing the height of these banks the movements would cease or be reduced. Opposition developed to this method on the ground that more material would be removed than was necessary; that by allowing the material that broke off to move into the cut the minimum amount would be handled, resulting in reduced costs, and the material left to itself would assume its natural slope.

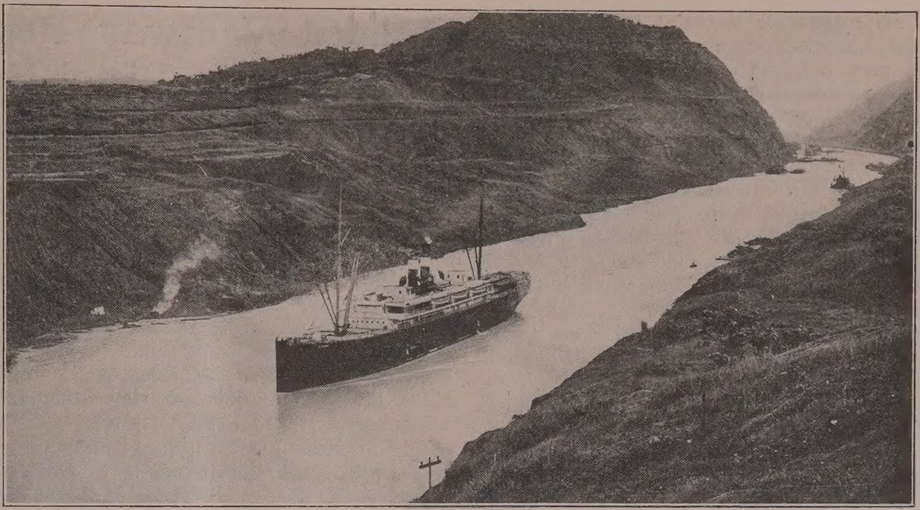
Two breaks occurred in rather rapid succession at Culebra in the latter part of 1910. As usual, each completely overturned the tracks at the bottom of the excavation, interrupted drainage, and seriously delayed operations in the prism. The later one of the two breaks determined the change in plan, and in January, 1911, the reduction of the height of the adjacent banks on either side of Gaillard Cut in the vicinity of Culebra was directed and begun. This work continued until December, 1913, at which time 6,533,924 cu. yd. had been removed from the east bank, and 8,797,990 cu. yd. from the west bank, resulting in slopes varying from 1 on 1.5 to 1 on 6.5 for the east side, and 1 on 2.46 to 1 on 4.35 for the west side. Those slopes were in a series of benches. The result of this method of procedure was that when the operations in the cut in the vicinity of Culebra were completed, prior to the admission of water, the breaks in the banks and the upward movement of the bottom had ceased entirely.

Early in 1911 a geologist was employed in connection with the earth movements. He proposed maximum and minimum lines for lightening the banks, together with suggested slopes. On the accompanying drawing are shown the maximum probable limits of the earth movement on the two sides, as predicted by him. The print also shows the areas over which the banks were lightened by excavation, and when the shovels were removed the benches within the areas marked by broken lines were all intact, the shovels having dug so as to remove all evidences of cracks. So far as could be foreseen, therefore, satisfactory slopes had been secured.

In the early part of 1914 small cracks had developed on some of the upper benches on the west side, and similar effects were noted on the east side. During the dry season the surface of the ground in this country cracks as the result of drying out, and in some instances these cracks are of considerable depth and extent. Whether those found on the benches were the ordinary dry season cracks or the result of structural weakness was not known, though



SECTION *A* BROKE AWAY FROM SECTION *B* AT ZION HILL



SECTION OF CANAL AT CULEBRA COMPLETED TO FULL WIDTH AND DEPTH

they resembled the former. To guard against emergencies, however, the shovels were returned and worked on the east bank, reducing the slope still more, until April 1, 1914; and on the west bank the shovels continued until June 14, 1914, by which dates the cracks had been entirely dug out. Steps were taken to drain the various benches.

A crack had existed for some years at the foot of Zion Hill, southwest of Culebra. The hill was pronounced as geologically secure against any movement, and when the material had been cut away from this bank the slope of the excavation extended to the crack or the limit marked as the maximum limit by the geologist. On the east side, toward the end of the dry season of 1913, a crack was found north of Gold Hill parallel to the cut, about 1300 ft. back from the face. It was not connected with the slope of the prism at either end. There were no cracks or breaks between it and the cut proper. There was apparently a slight settlement on the side of the crack nearest the cut, but none with the marked indications of a probable break. Steps, however, were taken to lighten the banks between the crack and the cut by sluicing away the high ground and by steam shovel operations. There were no indications of movement, and apparently the work done toward lightening the banks had been effective. It appeared, so far as could be determined, that a state of equilibrium had been secured and the waterway through the section was complete. Subsequent to turning in the water there were small slides on the east bank, north of Gold Hill, and also on the west side, but they were small, the material was easily removed, and they were typical of class-one slides.

East Bank Settles 20 Feet

No change occurred until Oct. 14, 1914, when, without warning, a section of the east bank settled vertically 20 ft. This section measured 2000 ft. along the prism face and extended back about 1000 ft. from the axis of the canal, generally along an irregular curved line. The bank was from 300 to 350 ft. above sea-level, and the extension of the ground eastward was relatively flat country. In the settlement the upper portion that broke away remained practically parallel to its original position, and the benches which formed the upper part of the slide had not changed their relative positions, though they were badly broken up, while the lower strata were squeezed out across the canal. Subsequently the broken mass moved into the cut, and until August, 1915, the dredges were able for the most part to keep up with the movement, when the movement on the west bank occurred, necessitating work on this side to the detriment of the east side.

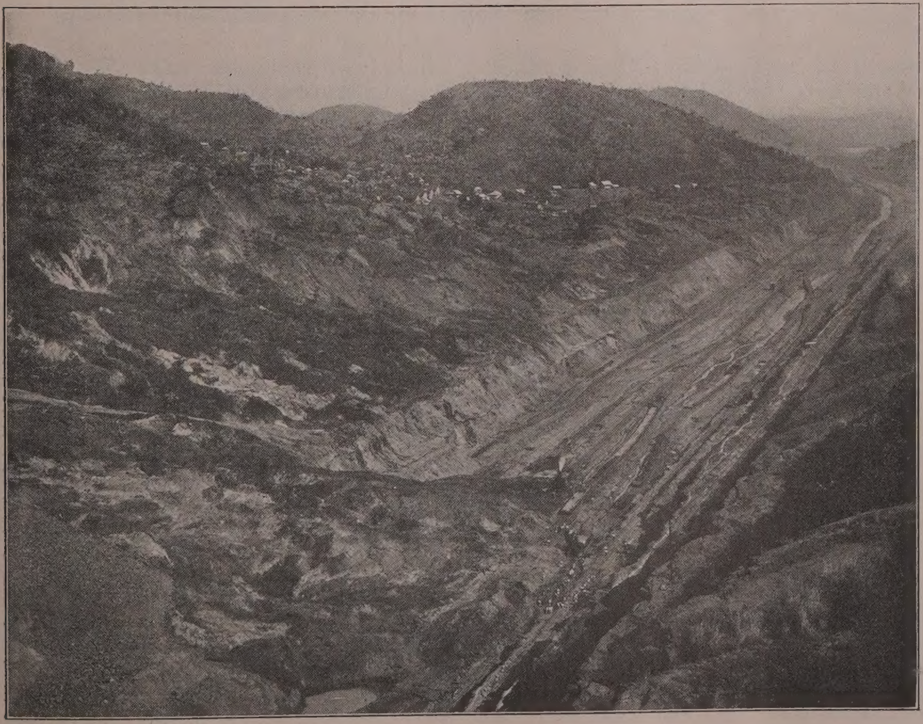
A crack was found on the slope of Zion Hill in June, 1914, but observation made upon it showed no movement until subsequent to the break on the east side, when a gradual but general breaking up of the west bank began. Subsequently, the cracks on Zion Hill extended to El. 480, the limit of the present break. The movement into the cut from the west bank occurred early in August, 1915, when a section of Zion Hill broke away and settled down.

This year's break at Zion Hill previously referred to, is generally along a curve. The movements from the two sides are toward the central portion of the inclosed area, and at this central portion is the main obstruction to the channel. In coming into the cut the mass on the east side is breaking up into waves which move down into the prism in succession; one now occupies part of the channel and another is forming up the slope of the hill. On the west bank this wave effect is also evident. Here the bank was pushed forward horizontally, the benches in some portions still maintaining their relative position with respect to each other, but the ground in their rear has settled, forming sink holes on the side away from the prism. The plat of the survey shows the earth wave effects. The map also shows the portion of the canal toward which the movement is concentrated, and the projection into the waterway that results. The crack shown on the north side of Gold Hill is a result of a sloughing off of material, the underpinning of which was removed by the break and slide of the east bank, similar to that which occurred on the south side of Gold Hill during the removal of Cucaracha slide.

Resort to Dredging

When the break of Oct. 14, 1914, occurred, it was evident that the large mass of material that had broken away must be handled by the dredges. Turning any part of the material away from the prism by sluicing operations was not possible on account of the natural lay of the ground, and, in fact, all material that could be handled by that method had been removed when the sluicing plant was installed on this bank. Steam shovels and trains could not operate on any portion of the broken mass, which was incapable of giving the necessary support.

There remained a stretch between this and the limiting crack to the east, but this ground was in such condition that before preparations could be completed for beginning work it would be broken up so that steam shovels could effect nothing. Subsequent developments have verified this. No further cracks or indications of a further extension eastward have occurred, and judging from past experience the existing cracks will limit the fracture, which is about 1300 ft. from the edge of the prism. Similar investigations and considerations on the west bank show there is no possibility of handling the material to advantage by steam shovels. The configuration of the ground



RUPTURE OF SUPPORTING ROCK MASS STARTED CUCARACHA SLIDE is such that all material in the present movement will be taken away long before the area involved could be reached. Like the east side, sluicing could only throw the material into the prism; similarly, it is believed that the limits of the break have been reached.

The conclusion reached, therefore, is that the only method is to remove the material as it comes into the cut by the dredges. These are handling nearly 1,000,000 cu. yd. per month at a cost of less than 30 cents per cubic yard. When the break occurred in October, 1914, and the subsequent breaking up of the west bank became evident, it was decided to augment the dredging fleet by another 15-yd. dipper dredge and three 1000-cu. yd. barges. The latter are in service; the dredge arrived last week and will be ready for use within two weeks.

ESTIMATED QUANTITIES

As to the amounts involved it is difficult to make predictions. As noted above, when Cucaracha broke loose in 1913 it was estimated that 2,000,000 cu. yd. were involved. More than 4,000,000 cu. yd. were taken out of the prism before the slide was entirely removed, in addition to 1,000,000 yd. washed away by the sluicing plant. In the present instance, estimating that the material must be removed from a slope extending from the bottom of the canal, reference 40, on the outward limits of the prism, up to the farthest limits of the breaks, on the theory that all the material above these planes will move into the cut, it is estimated that 7,000,000 cu. yd. will have to be removed before the slides are entirely done away with. If we assume a surface parallel to the existing one, starting from El. 40, the estimated quantity is 13,000,000 cu. yd. The resulting surface, as is the case with other slides that have been handled, will be irregular, and perhaps the more correct estimate will be between these two limits, or 10,000,000 cu. yd.

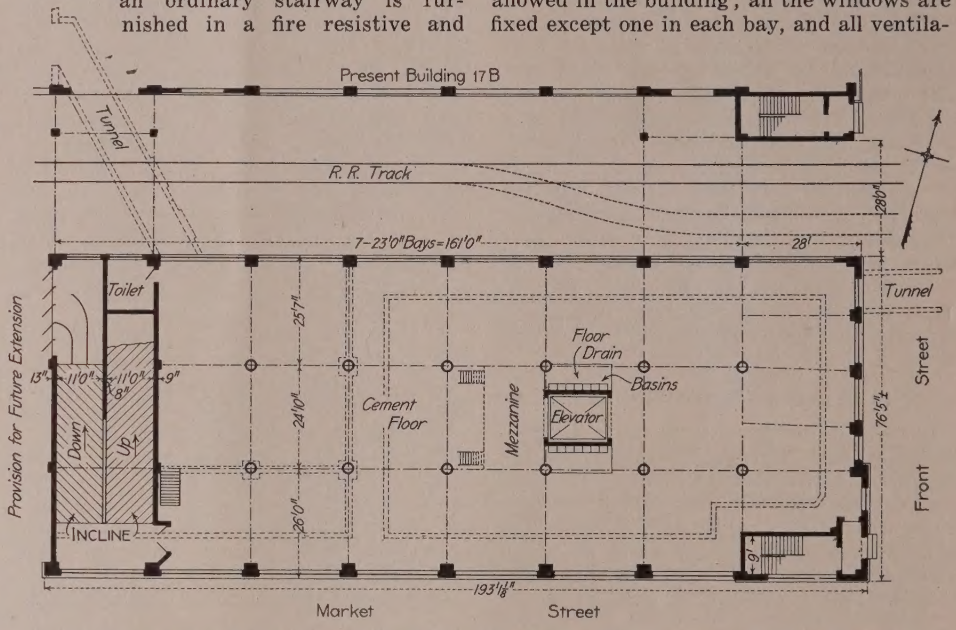
EFFORTS BEING DIRECTED TOWARD SECURING A CHANNEL

While the foregoing amounts are the estimates of what will have to be handled before all moving material is removed it is not to be assumed that the canal will be closed to navigation for this length of time. On the contrary, all efforts are being directed toward securing a channel. The estimated amount in the canal within the limits of the prism was about 500,000 cu. yd. when the prediction was made that the canal would probably be opened by Nov. 1, and the dredges could easily handle this amount within the time limit; but in view of the wave movements and the difficulty of breaking through the central obstruction it was not deemed wise to make any further predictions until the moving mass was in such shape that we had a channel through it which we felt reasonably sure could be maintained. To this end the dredges are operating to cut a channel wider than the full prism width, which will enable the maintenance of a channel more easily than heretofore. On Oct. 6 the length of the channel that was blocked was 1300 ft. This length has been reduced since then to 700 ft., but due to the continued movement we have been unable to break through the closure in the vicinity of Sta. 1787, and which is now about 100 ft. in length. When this is accomplished the lower waves can be more easily removed and more reliable predictions made than are now possible.

Inclined Walkways Replace Stairs and Elevators in New Victor Building at Camden

Safety in Exit Provided at Cost of Floor Space—Special Hollow Cast-Iron Interior Columns for Ventilation System

THE CABINET FACTORY, building 17C of the Victor Talking Machine Company's plant, at Front and Market Streets, Camden, N. J., contains some unusual features in building construction. The floor is similar to that used in other locations in the same plant, and consists of a flat slab supported by beams on the four sides, but with diagonal as well as square reinforcement. Inclined walkways 11 ft. wide, built with gradual slopes between concrete walls and occupying two complete panels at the northwest corner of the building in a practically smokeproof tower, are a unique solution of the problem of providing safe and rapid exit facilities. No passenger elevators whatever are used, but an ordinary stairway is furnished in a fire resistive and smoke-proof tower at the southeast corner, and stairs are provided for exits to the roof.



PLAN OF FIRST FLOOR—FIRST STORY CONSTRUCTION AND UNDERGROUND TUNNELS

In addition to these structural features, the design was further modified by the requirements of the owners that a very complete and effective system of interior heating and ventilation should be provided, the principal apparatus to be installed in a penthouse on the roof. As the floor space throughout is to be kept free from obstruction in order to insure a maximum of light, the interior columns are designed to provide the air ducts. For this purpose 24-in. hollow cast-iron columns 15 ft. long with brackets at the top to furnish seats for the reinforced-concrete beams, and openings on one side for the registers, were used. These columns are shown in the photograph. Some difficulty was experienced in obtaining perfect castings of this size, and a large percentage had to be discarded.

SPECIAL REQUIREMENTS MET

The new cabinet factory is about 193 ft. long by 76½ ft. deep and is connected to the present factory in the rear by a five-story bridge one bay wide, and by a tunnel for the trucking of material. The upper floors are also connected to the recently completed shipping building by a three-story bridge across Front Street, and the lower floor by a tunnel under the street, which is continued inside the building as shown on the first-floor plan. The building is six stories high, the general dimensions being shown on the accompanying plan and elevation, showing the unusually high stories, these being 15 ft. The exterior columns are faced with brick, with trimmings of Indiana limestone and full-panel bays of Lupton-type rolled-steel frame windows.

This building is used for the manufacture of finely finished cases, and therefore presents a special problem in ventilation, especially for the upper floors where the finishing is done. No dust or outside air is allowed in the building; all the windows are fixed except one in each bay, and all ventilation is to be wholly mechanical. The wood-finishing machines on the lower floors are to be furnished with special suction ducts to draw up the sawdust and shavings to an outside separator, from which they are removed to the furnaces and burned.

All floors except the first are built of reinforced-concrete slabs supported by beams on four sides, the exterior beams being carried above the floor in the usual manner to avoid cutting off the light. The building is of fire-resistive construction throughout, with electrical equipment and sprinkler protection. The interior columns are hollow cast iron, protected by 2 in. of concrete and an outside layer of cement plaster on metal lath. The exterior rectangular columns are of concrete reinforced with longitudinal rods and ties, except the columns carrying the steel plate girders of the bridges, which are of built-up I-section.

DESIGN OF FLOOR SLAB

The design of the 9-in. reinforced-concrete floor slabs was based upon the usual allowable unit stresses for the concrete and steel. All floors and the roof were designed for a live load of 150 lb. per square foot. The first floor is of concrete on earth fill,

CAST-IRON COLUMNS WITH VENTILATION OPENINGS AND BRACKETS

finished with 1 in. of cement mortar, with Master Builders' hardener. The runways had, in addition, 20 lb. of carborundum dust per 100 sq. ft. to roughen the surface and decrease the wear. All other floors are finished with maple flooring.

A veneer cellar which, to save time, was excavated after the building was erected, occupies several bays in the northeast part of the building. Openings are provided for a large freight elevator near the center, for the transfer of materials from the first floor to the upper floors, also for a special tray elevator from the veneer cellar to the first floor.

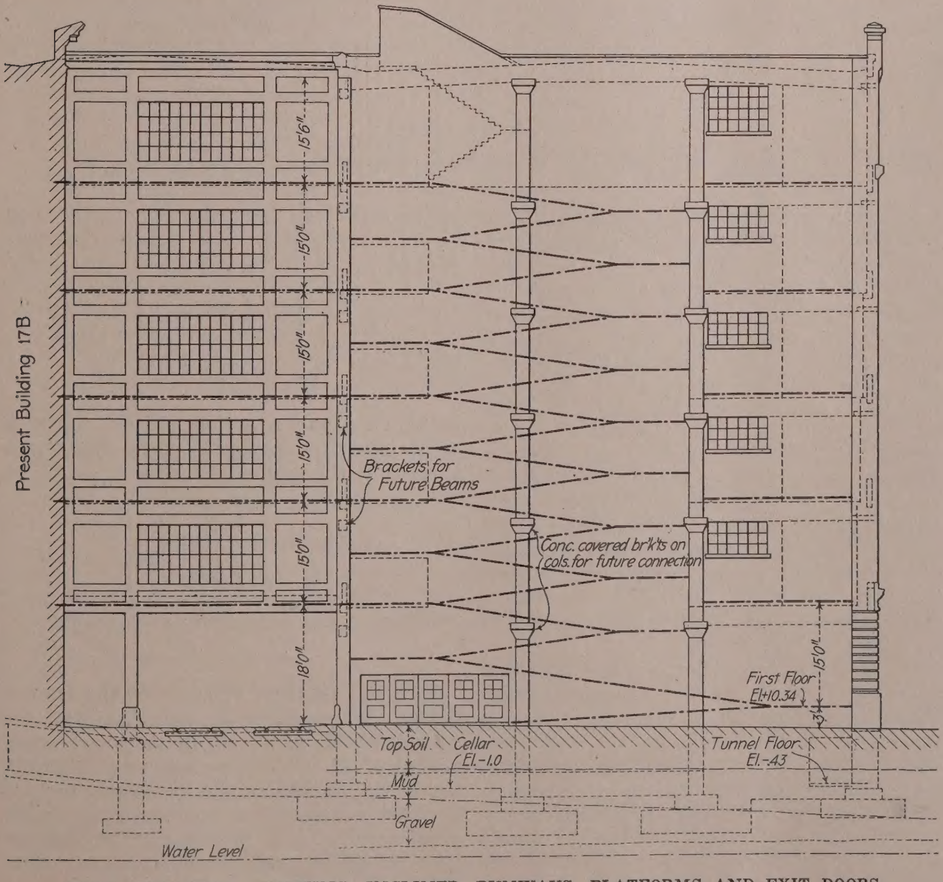
INCLINED-WALKWAY EXPERIMENTS

The main exit shown at the northeast corner of the building must provide for all employees of both the old and the new cabinet factory. In order to provide a safe and rapid exit, especially in case of fire, the owners authorized a careful investigation of the subject. Experiments were made to determine the time of exit of the employees in the present cabinet factory. The results indicate that the average time for one person to descend one flight of stairs is 20 sec. The file of men passed through the door at the rate of one man per second. The speed of men walking on the sidewalk was 5 ft. per second.

Based on this and similar data it is estimated that the proposed incline can empty the buildings, containing 3200 men, in 8¾ min. In case of a fire drill, with the four fire towers in use, including those in the present building, they could be emptied in a little more than 4 min. The rapidity of exit depends largely upon the number of doors. It is seen that five doors have been provided at the main exit and that guide railings leading to them insure safety and order in passing through.

The slope of the inclined walkway was selected, after trial, at 1¾ in. to the foot, which requires four inclines with three intermediate landings to rise 15 ft. between floors, as shown on the elevation, except from the first floor to the second, where one longer horizontal run was possible and three inclines could be used. The inclines are simple flat slabs 6 in. thick carried by reinforced-concrete walls.

The building was designed by Ballinger & Perrot, architects and engineers, of Philadelphia and New York, and the contract was awarded to Irwin & Leighton, of Philadelphia. The cast-iron columns were furnished by Phoenix Iron Works Company and J. C. Moyer & Company.



WEST ELEVATION, SHOWING INCLINED RUNWAYS, PLATFORMS AND EXIT DOORS

Curves on Winnipeg Aqueduct Built with Straight Sections of Forms

Careful Planning and Method of Laying Out Work Avoids Delay in Concreting as Well as Construction of Special Forms for Curves

THE USE of special forms for curved sections was done away with in building the Winnipeg aqueduct by making the 45-ft. traveling forms in 15-ft. sections and setting these sections on chords to the true curve. As the forms would not telescope on curves, careful planning of the work was necessary to have all forms, except the form set for the curve itself, advanced past the curve before the curve was concreted. This avoided the loss of a day or more in passing each curve, which would otherwise have been taken in allowing the curved section to set so that the forms under it could be moved ahead to clear the way for moving up any form that might be left behind the curve. This arrangement of the work, and the method of laying out the 15-ft. sections on the ground, were originated by James H. Fuertes of New York City, consulting engineer for the Greater Winnipeg Water District.

In approaching a curve, the contractors were instructed to leave out the curved section until all forms but the one next the gap had been moved ahead. This last form was then to be moved ahead, set in the gap and concreted on the same day with the third form ahead of it. The two intervening forms meanwhile would be concreted on the two days previous, together with the two forms ahead of the advance form concreted with the curve. This made it possible to move the forms ahead two at a time, and to concrete two, strip two and set up two each day.

It was assumed that the contractor would use forms in two sections of 45 ft. each, each 45-ft. section being carried on three travelers 15 ft. long, and each 15-ft. section of arch forms being made up of 5-ft. lengths, bolted together. The plans provided that two 45-ft. lengths of forms would be set up and concreted each day. The invert was laid in 15-ft. lengths, except closures, which were made shorter than 15 ft.

PLAN WHEN WORK STARTED AT CURVE

The aqueduct section on all curves would, when the forms were removed, permit 15-ft. lengths of collapsed form to pass through on the travelers, but would not permit them to pass through when the forms were in place on the curved portion. To build 90 ft. of completed section per day required six 45-ft. lengths, or 270 ft. of forms, to give three days' time for setting of the concrete, removal and re-erection of the forms. It was essential, therefore, in order to avoid trouble with moving forms ahead, to follow the schedule shown in Fig. 5 when the concreting of the arch began at a curve. On the fourth day, the forms concreted on the first day were moved forward six spaces. On the fifth day those concreted on the second day were moved up next to the ones set on the fourth day, and on the sixth day those concreted on the third. This cleared the aqueduct of forms, so that the section on the curve could be moved ahead through the open concrete arch.

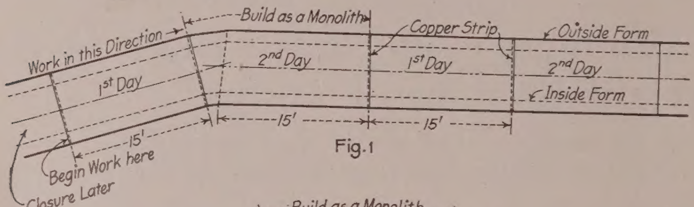


Fig. 1

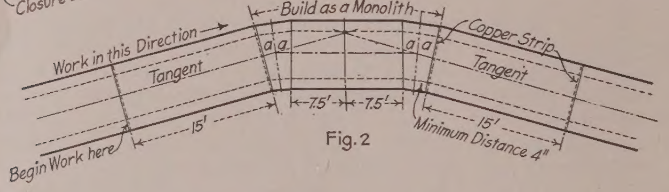


Fig. 2

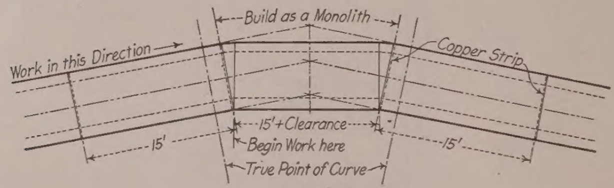


Fig. 3

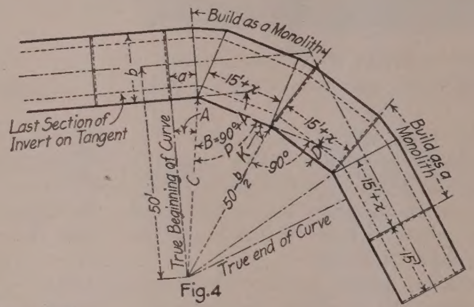


Fig. 4

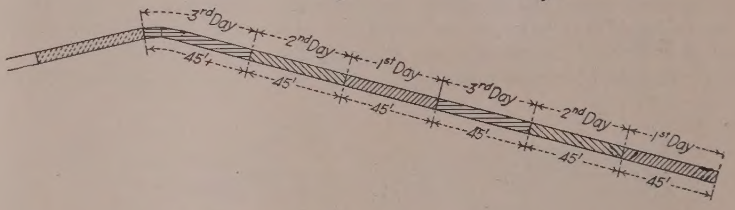


Fig. 5

CURVES ON WINNIPEG AQUEDUCT MADE WITH STRAIGHT FORM SECTIONS, AND WORK ARRANGED TO SAVE DELAY IN MOVING UP

Plan When Approaching Curve

When the work approached a curve so that the curved section had to be passed through in moving forms ahead, the forms were left out of the curved section until the last form on the tangent behind was ready to be moved. This was then set in the curve, filling in the gap of 45 ft. at the curve left for it. This required careful planning of the work in order to avoid a day's delay. Wherever possible, the work was laid out so that when the curve was reached the condition shown in Fig. 1 existed.

Curves Made with Short Tangents

If work began at a curve, for deflection angles up to and including 11 deg., the total curvature was made at one point, by prolonging the tangents to a point of intersection and placing inside forms on each tangent so as to leave a minimum of 4 in. clear space between the forms at the invert level on the short side of the curve. If the angle was great enough to require more than 4 in. between inside forms when outside forms just touched at the invert level, inside forms were set on each tangent so that the outside forms would just touch. The gap in each case was filled in with wooden forms.

In building the invert forms work began with the 15-ft. section to the rear of the angle point, as referred to the direction in which the work was proceeding. Copper strips were put in each end of this and of all alternate sections ahead. The invert section containing the angle was always built as a monolith.

For deflection angles greater than 11 deg. the curve was made in two angles, by placing one 15-ft. length of form across the arc. This was laid out by prolonging the two tangents to the point of intersection, and turning off at the point of intersection an angle equal to 180 deg. minus the deflection angle. This gave the radial line through the point of intersection. Next, two lines were staked out parallel to this radial line, 7½ ft. on each side, for the ends of the inside form. Then, in line with the tangents, was measured the distance from the end of the inside forms to the end of the last section of invert. This distance, $2a$ in Fig. 2, was divided, and half of it, a, was taken. From the points of bisection the chord was laid out, and where this cut the faces of the inside forms, at each end, was the center-line of the inside form for the 15-ft. section on the curve.

When Last Section Overran Point of Curve

If the work approached a curve and the end of the last invert section did not fall at the exact point for beginning the curve a different procedure was necessary, which was followed for all deflection angles. The tangents were extended to a point of intersection, and the exact ends of a true curve on the center line of the aqueduct were located. On approaching a curve the last invert section to be concreted on the tangent was the one whose front end was nearest to and not more than 5 ft. in front of the true point of the theoretical curve. Next, if the deflection angle in the aqueduct line was small enough so that a 15-ft. chord from the end of the concreted invert at the outside of the outside forms, on the short side of the curve, to the outside tangent did not make a greater angle with either tangent than about 18 deg., one 15-ft. straight section was used to make the bend, as shown in Fig. 3.

If, however, the deflection angle in the aqueduct was great enough to require more than one 15-ft. section of the invert to make the curve, from the end of the last concreted invert section nearest to the curve one 15-ft. section was used to join the end of this section with the theoretical curve of the outside line of the outside form. From this point to another on a 15-ft. chord to the true circle the next form was set, and so on, making the last 15-ft. section fall on the last tangent, as shown in Fig. 4. In Fig. 4, a equals the distance of end of the section past the true point of curve, and b equals the outside width of the outside forms at the bottom, out to out of angles at the ends of the forms.

$$\operatorname{Tan} A = \frac{a}{50 - \frac{6}{2}} \qquad B = 90^\circ + A$$

$$c = \sqrt{a^2 + \left(50 - \frac{6}{2}\right)^2}$$

$$\sin \frac{P}{2} = \sqrt{\frac{(s - m)\,(s - n)}{mn}}$$

in which $m = c$ and $n = 15 + x$, in which x is equal to the clearance for the flare of the angles at the ends of the forms.

$$S = \left[\frac{c + \left(50 - \frac{6}{2}\right) + 15 + x}{2}\right]$$

The deflection angle to the end of the first 15-ft. chord would then be $(90 + A) - P$.

To get the deflection angle for the second 15-ft. chord, there was first turned off the angle K to the left from the chord just found, which gave the direction of the radius.

$$\operatorname{Sin} \frac{K}{2} = \sqrt{\frac{s - \left(50 - \frac{6}{2}\right)(s - n)}{\left(50 - \frac{6}{2}\right)n}}$$

in which s and n are as above. From a right angle to the radius thus found was turned off the angle.

$$\text{arc sin} = \frac{\left(7.5 + \frac{x}{2}\right)}{\left(50 - \frac{6}{2}\right)}$$

which was the deflection angle sought.

The Rio Grande Project of the United States Reclamation Service in 1914 included 27,302 acres which produced crops valued at $1,160,720, an average of $42.51 per acre. Excluding the Sunnyside project in Washington, this is the highest average, according to C. J. Blanchard, Reclamation Service statistician, attained on any Government project.

Sand for Concrete and Cement Mortar Should Have "Jump" in Grading

New View, Based on Theoretical Grounds and Verified by Tests, Runs Counter to Theory That Particles Should Be Uniformly Graded

By ROBERT H. McNEILLY, C. E.
Assistant Professor of Civil Engineering, Vanderbilt University, Nashville, Tennessee

[*Sand for concrete and cement mortar, according to the accepted theory, should have its particles uniformly graded. Proceeding on theoretical grounds, however, Professor McNeilly argued that there should be a "jump" in the grading. Tests with laboratory mixtures confirmed the theoretical considerations. He concludes that the best sizing will include particles caught between the No. 4 and the No. 10 sieves, and the "fines" passing a No. 40 sieve. In other words, there should be a jump from the 40-size to the 10-size particles.* —EDITOR.]

IN 1912 the writer became interested in the subject of the fine aggregate in concrete, and since that time has made extensive studies of the various materials available for this purpose at Nashville, Tenn. A large proportion of the results presented in this article are purely experimental work, while quite a number of the tests were professional work for the Nashville, Chattanooga & St. Louis Railway, the Lightman-Sewell Stone & Pulverizing Company, T. L. Herbert & Sons, and others. This will explain the lack of uniformity in the methods used, which arose from the different purposes for which tests were made, and also from the gradual development of methods in the light of completed experiments.

WEAKNESS DUE TO FINE AGGREGATE

There is much evidence to show that the principal weakness in concrete is due to the fine aggregate, because all foreign substances, such as clay, loam and organic matter, naturally gravitate to the "fines" in ordinary crushed material, while natural sands are usually "dirty." Therefore it may be stated as a general principle that if the coarse aggregate be a reasonably strong stone or gravel, the trouble, if trouble does develop in the concrete, may be laid to the account of the fine aggregate in the large majority of cases. For this reason it was deemed sufficient to investigate the mortar only instead of the whole concrete mass. Tensile tests, as they gave so much more uniform results, were considered sufficient to indicate the relative value of the aggregates tested.

With regard to the methods used, the sieving was done by hand, and the mortars were gaged by experience to a rather dry consistency. Standard methods described in Bulletin 33, U. S. Bureau of Standards, were used in all particulars except that the mortars were tamped with the handle of the trowel, which was found necessary in many cases, to force the mortar properly into the molds.

LOGICAL SEPARATION OF SIZES

In beginning the study of an ideal distribution of size of grains based on the theory of "voids," it was first determined to establish a logical separation of sizes, and the following principles were used as a basis of separation: Fig. 1 represents in plan a pile of uniform spheres piled so as to give the least void space. The spheres A_1, A_2, etc., B_1, B_2, etc., C_1, C_2, etc., are on a lower level, while D_1, D_2, etc., E_1, E_2, etc., are on an upper level.

It is evident from an inspection of Fig. 1 that if d_1 is the diameter of the large spheres, smaller spheres of diameter d_2 can be inserted between each set of six spheres, as $A_2B_1B_2D_1D_2E_1$; and still smaller spheres of diameter d_3 can be placed in the openings between each four-sphere unit, as $B_2D_2E_1E_2$. A mathematical examination of the relative diameters of these spheres gives the following:

$$d_1 : d_2 : d_3 = 1 : 0.41 : 0.22$$

(Note: For demonstration see Taylor and Thompson's "Plain and Reinforced Concrete," page 170.)

Therefore the following separation of sizes was considered logical: If d_1 is the average diameter of the largest particles considered, then we should divide the material into two other sizes of d_2 average diameter and d_3 average diameter, such that $d_1 : d_2 : d_3 = 1 : 0.41 : 0.22$. We can then take as the very finest material, which fills in between the particles of d_1, d_2 and d_3 diameter, all the particles which pass the sieve upon which the particles of average diameter d_3 are caught.

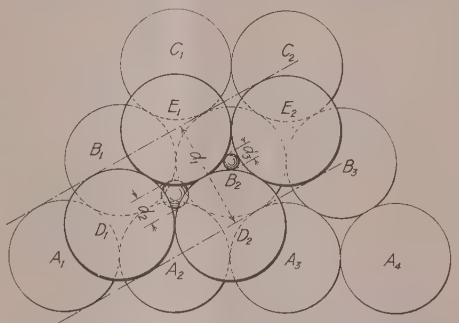


FIG. 1—VOIDS BETWEEN UNIFORM SPHERES

SIZES OF PARTICLES

Since it is a universal American practice to class all material finer than ¼ in. in size as fine aggregate or "sand," the material which passed a No. 4 sieve and was caught on a No. 10 sieve was assumed arbitrarily to be the coarsest particles to be considered. These particles were found, by experiment on Cumberland River sand, to have an average diameter of 2.93 mm. Therefore, if we assume d_1 as 2.93 mm., d_2 should equal $2.93 \times 0.41 = 1.20$ mm., and d_3 should equal $2.93 \times 0.22 = 0.64$ mm.

TABLE NO. 1—EXPERIMENTS ON CUMBERLAND RIVER SAND TO DETERMINE AVERAGE SIZE OF GRAINS

Sieve analysis						
Passed sieve	Caught on sieve	Number of grains taken	Total volume displaced, cu. cm.	V, volume of average size grain, cu. cm.	$d = \sqrt[3]{6v/\pi}$ diam. av. grain, mm.	Theoretic size desired
No. 4	No. 10	970	12.7	0.013100	2.93	$d_1 = 2.93$
No. 10	No. 20	2,126	2.5	0.001172	1.32	$d_2 = 1.20$
No. 20	No. 30	20,000	4.9	0.000245	0.776	
No. 20	No. 40	24,000	3.5	0.000145	0.65	$d_3 = 0.64$

Note—The Nos. 4-10 grains and the Nos. 10-20 grains taken in this table were actually counted from carefully quartered volumes of sieved sand; the Nos. 20-30 and the Nos. 20-40 grains were estimated by counting 2500 and 3000 grains of each respectively and then multiplying this volume eight times by balancing a like amount of such grains against these in an analytical balance. These grains were then carefully poured into a burette partly filled with water. The rise of the water was taken as the total volume displaced and the diameter of the equivalent sphere calculated.

Table 1 shows the results of experiments on Cumberland River sand to determine the average size of grains passed by and caught upon certain selected sieves.

From this table we can therefore formulate the following as a proper separation of sizes for a logical sieve analysis under the conditions assumed: The *coarse* particles should be those which pass a No. 4 sieve and are caught on a No. 10 sieve. The *large-intermediate* particles are those caught between the No. 10 and the No. 20 sieves. The *small-intermediate* particles are those which are caught between the No. 20 and the No. 40 sieves, while the *fines* are those which pass the No. 40 sieve. In addition to this it is often desirable to determine the percentage of material which passes the No. 100 and the No. 200 sieves in order that the character of the fines may be more closely studied.

This method of granulometric analysis seems far more logical than the prevalent practice of using a much larger number of sieves, because one becomes lost in a maze of meaningless figures unless a Fuller's curve is drawn, which in turn is hard to grasp unless the same scale is universally used. Furthermore, the methods in use for drawing conclusions from these Fuller's curves are exceedingly uncertain.

MORTAR OF MAXIMUM DENSITY

Having determined upon this logical sieve analysis, let us now attempt to formulate a distribution of these sizes, such that the mortar formed will have the greatest possible density, which should also give the greatest strength and durability to the concrete.

Returning to a consideration of the pile of uniform spheres shown in Fig. 1. Each sphere of d_1 diameter will touch three spheres of d_2 diameter, while each sphere of d_2 diameter will touch six spheres of d_1 diameter. Therefore, in a pile of n spheres of d_1 diameter there will be $3n \div 6 = n/2$ spheres of d_2 diameter. Similarly, since each d_1 sphere touches five d_3 spheres, while each d_3 sphere touches only four d_1 spheres, there will be $5n/4$ spheres of d_3 diameter. Let V_1, V_2 and V_3 be the total volume of the sum of the spheres of d_1, d_2 and d_3 diameter respectively in the pile. Then

$$V_1 : V_2 : V_3 = d_1^3 : \frac{d_2^3}{2} : \frac{5d_3^3}{4}$$

$$= 1 : \frac{(0.41)^3}{2} : \frac{5(0.22)^3}{4}$$

$$= 1 : 0.03446 : 0.01331$$

Therefore, if uniform spheres of d_1 diameter be systematically piled to give the greatest density, and in the openings of these be inserted other spheres of d_2 and d_3 diameter, the weight of the sum of the spheres of d_2 diameter = 3.45 per cent of the weight of the large spheres of d_1 diameter, and those of d_3 diameter weigh 1.33 per cent of the weight of the large spheres of d_1 diameter.

Fig. 2 represents at A the coarse particles of d_1 average diameter of a crushed material when close packed dry. Each particle touches the contiguous grains, and experiment on crushed Lightman limestone showed 37.6 per cent void space instead of the 26 per cent void which they should, theoretically, have shown if they had been uniform spheres systematically piled, or the 44 per cent least void which Mr. Fuller determined by experiment for uniform spheres piled at random. (See Taylor and Thompson, page 170.)

EFFECT OF ADDING CEMENT

Fig. 3 shows at C the effect of adding cement and other fine material to the packed coarse particles of A and making a mortar. The original particles have now been separated until they must present *at least* 50 per cent of space to be filled by the cement and other fines.

However, just as in the case of the dry-packed grains of A we could insert a few grains of d_2 and d_3 diameter (as shown at B in Fig. 2), so we may insert the same number of these intermediate-size grains in C (Fig. 3) without further separating the coarse particles. (This is shown at D, Fig. 3.)

Attention is now directed to Fig. 4, as a suggestion of the pernicious effect of adding too many intermediate particles to the grains shown at C, Fig. 3. The original coarse grains of d_1 diameter are simply wedged apart; their interlocking is destroyed, and the space to be filled by cement and other fines is greatly increased. This is exactly what occurs in most natural river sands—the intermediate and Nos. 40-100 particles vastly exceed the weight of the coarse grains, while to aggravate the condition the material smaller than that which passes the No. 100 sieve is almost entirely missing (having been carried off by the water) and cannot assist the cement in filling in between the smallest spaces.

Referring again to Fig. 3, D, and our previous discussion of the desired ratio of intermediate to coarse grains, we based our analogy on uniform spheres systematically arranged. The coarse particles are not, however, perfect spheres, nor are they systematically placed, yet, since the total void is increased, surely the same number of particles of d_2 diameter, and, say, twice the number of those of d_3 diameter, can be beneficially inserted in the spaces between the grains of d_1 diameter without wedging them farther apart.

Therefore the proportions of each size shown in Table 2 (using the foregoing assumptions) were considered logical ones.

Thus it is evident that the percentage of fines in the aggregate should be decreased as the proportion of cement is increased, and vice versa. For example: A 1 : 3 mortar should have 25 per cent cement and 21.94 per cent fine aggregate passing the No. 40 screen, while a 1 : 2 mix would have 33 1/3 per cent cement and 13.61 per cent similar fine aggregate. (These figures are slightly in error, if we proportion by weight, due to disregarding the difference in specific gravity of cement and aggregate.)

TABLE 2—LOGICAL PROPORTIONS OF SAND

		Sieve Nos.
Coarse	d_1—50 per cent of total volume by weight of particles caught between	4 and 10
Intermediate	d_2—3.45 per cent x 50 per cent = 1.73 per cent of total volume by weight of particles caught between	10 and 20
	d_3—2 x 1.33 per cent x 50 per cent = 1.33 per cent of total volume by weight of particles caught between	20 and 40
Fines	100 per cent—(50 per cent + 1.73 per cent + 1.33 per cent) = 46.94 per cent of total volume by weight of particles which pass the No. 40 sieve, plus the cement.	

Mortars proportioned according to the above and designated, "Theoretical Mixtures," are shown in Table 3 at Nos. 5, 6, 8, 9 and 31; while No. 7 has its intermediate grains increased 50 per cent over the theoretic value and the fines correspondingly decreased.

REVISED THEORETICAL PROPORTIONS

Before leaving this subject and proceeding to an examination of Table 3, it should be noted that the percentage of the d_2 and d_3 diameter particles is so trifling (only 3 per cent of the total) that this weight of intermediate grains would probably be caught with the Nos. 4-10 material in any commercial sieving operation on account of imperfect sieving. Therefore we are justified in revising these theoretic proportions for commercial practice as per Table 4.

It will further benefit the mortar, unquestionably, if the cement and the proper proportion of this pass-40 aggregate be first intimately mixed, probably with a slight grinding or rubbing, not sufficient to materially reduce the particles in size, but merely to a degree sufficient to break down thoroughly the soft lumps in the cement and incorporate the aggregate in it. This may tend to promote the proper hydration of the cement also by helping to prevent its "balling up" when the water is added.

TABLE 4—THEORETIC PROPORTIONS REVISED FOR COMMERCIAL PRACTICE

53 per cent (coarse) Nos. 4–10 aggregate.
47 per cent (fine) pass No. 40 aggregate plus the cement.

For a 1:3 mortar this would be:
53 per cent (coarse) Nos. 4–10 aggregate.
22 per cent (fine) pass No. 40 aggregate.
25 per cent cement.

For a 1:2 mortar it would be:
53 per cent (coarse) Nos. 4–10 aggregate.
13⅔ per cent (fine) pass No. 40 aggregate.
33⅓ per cent cement.

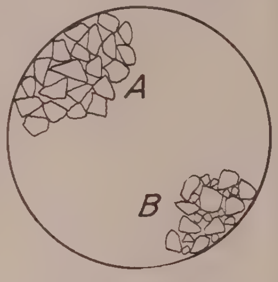


FIG. 2—PARTICLES d_1

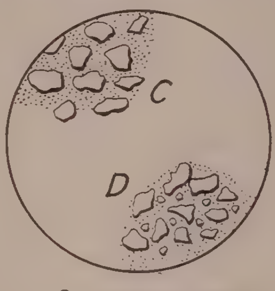


FIG. 3—CEMENT ADDED

A, close packed; B, smaller particles in voids; C, cement only added; D, smaller particles in voids.

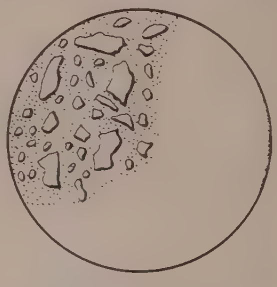


FIG. 4—TOO MANY "INTERMEDIATE" PARTICLES

(For an extensive study of this lack of proper hydration of cement in concrete see the articles by Nathan C. Johnson in the issues of the Engineering Record from Jan. 28 to March 13, 1915. In these articles on the "Application of the Microscope to the Study of Concrete" many other interesting questions related to the points here discussed are elaborated with profuse illustrations.)

TESTS

Table 3 shows the results of tests on several aggregates proportioned upon this theory as a basis, together with comparisons showing tests on practically every commercial fine aggregate upon the market at Nashville, Tenn.

In testing out the theory it was determined to eliminate, so far as possible, all other influences, such as clay, shale and organic matter, and let the material stand upon the distribution of the sizes of its constituent particles alone. To this end selected magnesian limestone from the Lightman quarry at Nashville was pulverized by hand for mortars Nos. 5, 6, 7 and 31, as well as for the tests made to determine the effect of material finer than that which was caught on a No. 40 sieve.

A chemical analysis of this stone made Feb. 14, 1913, gave the following results:

	Per cent
Insoluble residue (silica, etc.)	3.42
Oxides of iron and alumina (Fe_2O_3, Al_2O_3)	.65
Carbonate of lime ($CaCO_3$)	89.11
Carbonate of magnesia ($MgCO_3$)	6.81
	99.99

Directing attention to Table 3, it will be noted that mortars 42-46 inclusive show that silicious and calcareous fines when mixed with cement in the proportion of 3 cement to 1 fines does not materially decrease the strength of neat cement mortar, and may even increase this strength. Mortars 47-50 inclusive, however, show that if cement is adulterated by one-third of its weight of these fines and then tested with standard sand the strength is greatly decreased. Although mortar 3 shows that aggregate fine enough to pass a 200 sieve is about 35 per cent weaker than standard sand, still mortar 4 shows that the pass-40 fines (which contain one-third of this material finer than 200 mesh), makes a stronger mortar than standard sand. One characteristic of this finely pulverized limestone is worthy of comment—it is exceedingly "smooth," acting almost as a lubricant and thus must promote the density of a concrete in which it is used. (Incidentally these tests show strikingly the fact that standard sand tests are much the best criterion by which to judge the strength of a cement.)

THEORETICAL MIXTURES

The theoretical mixtures 5, 6, 7 and 31 were made of Lightman limestone pulverized by hand and proportioned as has been previously explained. The pass-40 fines of the aggregate were first mixed intimately with the dry cement. (About 600 grams of the mixture was first gently ground in a mortar for about three minutes till the color became uniform and then passed through a No. 30 sieve.)

Mortars 5 and 31 have all the fines which pass the 40 sieve left in while No. 6 has the pass-200 material removed from the fines. This mortar (No. 6) shows the greatest density of any mortar tested, both in the dry mix and in the finished briquette. It also shows the greatest 7-day strength of any mortar tested in the 1 : 3 proportion, reaching the remarkable value of 7 per cent greater than neat cement. However, its 28-day strength fell slightly under that of No. 5, which would be a far easier material to produce commercially.

Mortar 7 has all the material which passed the 100 sieve removed from the fines, while the proportion of the intermediate grains was increased 50 per cent over the theoretical proportions. This mortar proved to be next to the densest mortar tested, but did not show up so well as 5 and 6 in the strength tests.

Mortar 31 shows exceedingly interesting results in that the highest strengths attained were gotten with this mortar, which is of the customary proportion used in reinforced concrete (1 : 2 : 4). The results, 25 per cent greater than neat cement on the 7-day and 10 per cent greater on the 28-day test, are unprecedented; yet, reasoning upon the analogy of a glued wood joint, where the greatest strength is given by the thinnest joint, it is to be expected that a properly proportioned mortar should give a greater strength than neat cement, and that a point is reached where the addition of more cement weakens the mortar. These tests indicate that this point is reached somewhere near the 1 : 2 mix for Lightman limestone. It is worthy of comment that practically every coarse particle was broken in the briquettes of mortars made of the theoretic mixture of this limestone. The three briquettes tested in 28 days, furthermore, showed a remarkable uniformity, which is exceedingly unusual with such high strengths, and indicates great uniformity of product, which is, if anything, more desirable than mere strength in a structural material. Note also the great density and a specific gravity—as great as Cumberland River gravel, Nos. 16 and 17, with all voids deducted. (In this connection note the high percentage of void in the neat cement mortar No. 1. This is 40.8 per cent—nearly three times as great as the theoretical limestone mixtures.)

COMMERCIAL FINE AGGREGATES

Mortar 10 was made of regular Lightman limestone screenings. The quarry is remarkably clean and free from bands of shale. Moreover the screenings show comparatively little fines and the coarse grains are notably flat disk-like shapes, so that the material, when used alone, has not given entire satisfaction because of a tendency of the cement in wet mixtures to flush out of the screenings and separate from them.

It was for this reason that the material which goes by the trade name of "topping" was put upon the market. This material is prepared by taking the material 3 in. and over in size which has been rejected by the whole screening plant at the quarry and is thus absolutely free from clay, shale, or even the softer portions of the formation; then passing it through a Williams pulverizer, which reduces nearly half of it to a rock "meal," while the larger particles are more nearly spherical and cubical in shape than is the case with the screenings. The name "topping" is taken from its use as a top wearing surface for sidewalk construction, and as such gives a remarkably dense, tough surface very white in color, which is locally replacing to a great extent the crushed granite formerly imported and used for this purpose.

Mortar 11 shows tests upon this topping, and No. 12 shows tests on a mixture of half

TABLE 3—DETAILED TESTS ON FINE AGGREGATE

Number of Mortar	Aggregate Used	Specific Gravity of Material	Sieve Analysis								Per Cent of Voids in Packed Dry Mixture	Specific Gravity of Briquette	Per Cent of Voids in Briquette	*Tensile St'gth in 7 Days, Lbs. per Sq. In. Av'ge	Per Cent of St'gth of Standard Sand	Per Cent of St'gth of Neat Cement	Relative St'gth	*Tensile St'gth in 28 Days, Lbs. per Sq. In. Av'ge	Per Cent of St'gth of Standard Sand	Per Cent of St'gth of Neat Cement	Relative St'gth
			Per cent caught between sieve numbers																		
			+4	4 and 10	10 and 20	20 and 40	Pass 40	40 and 100	100 and 200	Pass 200											
1	Sample Royal Cement	3.125	0	0	0	Trace	100	7	24	69	45.1	1.85	40.8	597	226	100	4	750	228	100	1
2	Standard sand	2.66	0	0	0	(20-30) 100	0	0	0	0	27.8	2.17	21.9	264	100	44	16	328	100	44	17
	Laboratory mixtures. 1 : 3 with No. cement sample:																				
3	Lightman limestone	2.703	0.0	0.0	0.0	0.0	100	0	0	100	.....	.....	.....	166	63	28	21	212	65	28	.....
4	Lightman limestone	2.703	0.0	0.0	0.0	0.0	100	51.3	15.0	33.7	38	.....	.....	270	102	45	15	392	119	52	12
5	Theor. mixt. 1, limestone	2.65	0.0	66.6	2.4	1.7	29.3	15.0	4.4	9.9	23.4	2.35	15.1	622	235	104	2	733	223	98	2
6	Theor. mixt. 2, limestone	2.65	0.0	66.6	2.4	1.7	29.3	18.1	11.2	0	21.0	2.38	14.1	635	241	107	1	713	217	95	3
7	Theor. mixt. 3, limestone	2.65	0.0	66.6	3.6	2.5	27.3	27.3	0	0	22.7	2.37	14.4	617	233	103	3	687	210	92	4
8	Theor. mixt. 4, crushed gravel, washed	2.38	0.0	66.6	2.4	1.7	29.3	16.8	8.1	4.4	24.2	2.12	18.1	485	183	81	8	593	181	80	9
9	Theor. mixt. 5, crushed gravel, unwashed	2.38	0.0	66.6	2.4	1.7	29.3	15.2	5.3	8.8	24.0	2.07	20.0	448	169	75	10	589	179	79	10
	Commercial fine aggregates. 1 : 3 with No. 1 cement sample:																				
10	Limestone screenings	2.65	11.0	60.8	18.0	4.3	5.9	2.2	1.0	2.7	.....	2.36	14.8	581	220	97	6	664	202	89	6
11	Limestone topping	2.65	0.0	16.2	24.9	16.6	42.3	17.8	12.2	12.3	.....	2.30	16.9	595	225	100	5	657	201	88	7
12	Limestone, ½ topping, ½ screen	2.65	5.5	38.5	21.4	10.5	24.1	10.0	6.6	7.5	.....	2.24	19.1	571	216	96	7	700	214	93	5
13	Crushed gravel, washed	2.38	2.7	47.9	28.7	12.0	8.7	5.1	1.9	1.7	.....	2.05	20.8	372	141	62	11	455	139	61	11
14	Crushed gravel, unwashed	2.38	1.7	47.1	20.6	10.5	20.1	10.5	4.3	5.3	.....	1.96	24.3	318	120	53	14	354	108	47	15
15	Crushed gravel, unwashed	2.38	3.6	51.1	19.3	8.4	17.6	9.3	3.2	5.1	.....	2.15	16.9	480	182	80	9	654	199	87	8
16	River sand, pumped	2.59	0.0	14.1	16.1	20.5	49.7	47.5	1.8	Trace	.....	2.05	25.5	219	83	37	18	319	97	43	18
17	River sand, dredged	2.59	0.0	7.2	9.2	16.2	67.4	66.5	0.9	Trace	.....	1.925	29.2	163	62	27	22	224	68	30	24
18	Limestone screenings	.....	0.0	48.7	20.0	11.4	19.9	10.5	3.9	5.5	.....	.....	.....	336	127	56	13	364	111	49	14
	1 : 3 mix with No. 19 cement sample:																				
19	Sample 19 Royal Cement	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	597	273	100	4	729	263	100	1
20	Standard sand	.....	.....	.....	.....	.....	.....	(40-60)	.....	(Pass 60)	.....	.....	.....	219	100	37	18	277	100	38	21
21	River sand, washed	.....	1.0	21.0	12.1	31.7	34.2	27.1	.....	7.1	.....	.....	.....	191	87	32	20	300	108	41	19
22	River sand, sewage added	.....	1.0	21.0	12.1	31.7	34.2	27.1	.....	7.1	.....	.....	.....	151	69	25	23	274	99	38	22
23	River sand	.....	0.7	11.3	7.9	18.0	52.1	40.6	.....	11.5	.....	.....	.....	106	48	17	27	146	53	20	27
24	River sand, sterilized	.....	0.7	11.3	7.9	18.0	52.1	40.6	.....	11.5	.....	.....	.....	147	67	25	25	240	87	33	23
25	Bank sand	.....	0.5	9.5	6.0	28.6	55.4	42.7	.....	12.7	.....	.....	.....	193	88	32	19	356	128	50	13
26	River sand	.....	0.0	0.5	1.0	42.6	55.8	42.6	.....	13.2	.....	.....	.....	150	68	25	24	215	78	29	25
27	River sand	.....	3.3	19.8	12.2	11.5	53.2	35.6	.....	17.6	.....	.....	.....	223	102	37	17	293	103	40	20
28	Bank sand	.....	0.0	2.2	3.2	25.2	69.4	46.0	.....	23.4	.....	.....	.....	140	64	23	26	175	63	24	26
29	Limestone screenings	.....	8.1	44.8	21.4	11.2	14.6	8.1	.....	6.5	.....	.....	.....	337	154	56	12	330	119	45	16
	1 : 2 mix with No. 1 cement sample:							40 and 100	100 and 200	Pass 200											
30	Standard sand	2.66	.....	.....	.....	.....	.....	.....	.....	.....	29.4	2.24	20.4	409	100	69	4	478	100	64	3
31	Theor. mixt. 6, limestone	2.65	0	75	2.7	2.0	20.3	10.4	3.0	6.9	28.0	2.39	14.9	748	183	125	1	825	173	110	1
32	Crushed gravel, unwashed	2.38	3.6	51.1	19.3	8.4	17.6	9.3	3.2	5.1	.....	2.09	20.5	546	134	91	2	783	164	104	2
	1 : 2 mix with No. 19 cement sample:																				
33	Standard sand	2.66	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	293	100	49	7	396	100	54	6
34	River sand	Same	as No.	21							.....	.....	.....	359	122	60	6	365	92	50	7
35	River sand	Same	as No.	23							.....	.....	.....	135	46	23	11	221	56	30	11
36	Bank sand	Same	as No.	25							.....	.....	.....	278	95	47	8	311	79	43	9
37	River sand	Same	as No.	26							.....	.....	.....	203	69	34	10	294	74	41	10
38	River sand	Same	as No.	27							.....	.....	.....	379	129	63	5	418	106	57	4
39	Bank sand	Same	as No.	28							.....	.....	.....	248	85	41	9	364	92	50	8
40	Limestone screenings	Same	as No.	29							.....	.....	.....	448	153	75	3	400	101	55	5
	Effect of very fine material upon Portland cement mortar. 1 : 0.33 mix with No. 1 cement sample:																				
42	Limestone	2.703	0	0	0	0	100	0	0	100	.....	.....	.....	565	...	95	4	673	...	90	4
43	Limestone	2.703	0	0	0	0	100	0	100	0	.....	.....	.....	565	...	95	4	741	...	99	2
44	Limestone	2.703	0	0	0	0	100	100	0	0	.....	.....	.....	662	...	111	2	652	...	87	5
45	Limestone	2.703	0	0	0	0	100	51.3	15.0	33.7	42.75	.....	.....	693	...	116	1	710	...	94	3
46	Crushed Ottowa sand	2.66	0	0	0	0	100	55	18	27	.....	.....	.....	570	...	96	3	790	...	105	1
	Mortars 43-46, treated as adulterated cement and tested, 1 : 3 with standard sand. (Comparisons with mortar No. 2):																				
47	1 part mortar 43 : 3 parts standard sand	.....	Finest aggregate, No. 100–No. 200								.....	.....	.....	205	77.5	...	2	269	82	...	2
48	1 part mortar 44 : 3 parts standard sand	.....	Finest aggregate, No. 40–No. 100								.....	.....	.....	145	55	...	4	237	72	...	3
49	1 part mortar 45 : 3 parts standard sand	.....	Finest aggregate, Pass No. 40								.....	.....	.....	158	60	...	3	230	70	...	4
50	1 part mortar 46 : 3 parts standard sand	.....	Finest aggregate, Pass No. 40								.....	.....	.....	206	78	...	1	285	87	...	1

*Average three briquettes.

topping and half screenings, as used in the construction of the Cleveland Street viaduct at Nashville.

As a suggestion of the probable cost of producing high-grade fines for mixing with cement and adding to the coarse grains of a lower grade aggregate, it may be noted that "topping" sells locally at retail for $1.50 per ton (of 2000 lb.), while screenings brings $1.10 per cubic yard (of 2300 lb.)

Crushed Gravel

Mortars 8, 9, 13, 14, 15 and 32 show tests upon a new material upon the local market—crushed Cumberland River gravel. This gravel is silicious, and mortars 8 and 9, which were made of a theoretic mixture of this material, failed to show quite as good results as the commercial material. Too much weight should not be given this result, however, because this gravel is of a variable and conglomerate character, and a thorough testing out of the theory on a silicious aggregate would demand that it be tried upon pure quartz crushed by hand to insure cleanliness. However, there is strong indication again that the unctuous "lubricating" effect of the limestone fines greatly assists in producing density in the mortar, and there is also an indication that the chemical reactions in the setting of cement take place better under basic conditions than acid, and unquestionably the set is accelerated.

River Sand

No further comment seems necessary upon the other materials presented in these tests except to say that mortars 18, 29 and 40 represent the usual run of local limestone screenings, which carry more or less impurities of shale and clay, while 16, 17, 23, 24, 27, 35 and 38 show tests upon the great source of fine aggregate at Nashville—the Cumberland River sand. This sand is of a quite inferior quality, as it always contains coal from the coal measures over which the river passes in its upper reaches, as well as silt, floating seeds and small particles of drift. As compared with sands in 21 and 25 it contains a much larger number of bacteria, as the river is formed into a long pool by the Government dam below Nashville, and this pool receives the sewage of the city. Tests 22 and 24 were made to examine into the effect of sewage.

However, by far the greatest objection to this Cumberland River sand is its lack of uniformity, which in this case is very great, but can be urged against almost any natural sand and against many crusher screenings, unless special precautions are taken to insure uniformity; and sand tests, as has been repeatedly urged, are of little value unless the product actually used in the work closely conforms at all times to the sample tested.

Conclusions

1. The usually accepted theory that a uniformly graded "sand" is the best fine aggregate for cement mortar is not correct. The best type of fine aggregate, certainly for crushed limestone, is one which is composed almost entirely of fairly uniform coarse grains with practically no intermediate sized grains, and sufficient very fine material to fill in, together with the cement, between these grains as they are actually separated in the mortar.

2. The determination of the voids in the dry-packed material, without the cement added, has practically no value in guiding judgment as to a given aggregate.

3. The best sizing of grains in a commercially sieved aggregate is about as follows: 53 per cent to be caught between the No. 4 and the No. 10 sieves; 47 per cent fines to be passed by the No. 40 sieve (this includes the cement).

4. There is every reason to believe that the coarse aggregate in concrete could be beneficially sized on a basis similar to the above; that is to say, there should be a jump in size from very coarse to quite fine instead of the usually accepted "graded" material.

5. The very fine material in the fine aggregate (pass-40 grains) should be exceedingly clean, dependable material, and should be intimately mixed with the cement, probably with slight grinding, before adding it to the concrete or mortar materials.

6. There seems, unquestionably, to be a point where the increase in the proportion of cement weakens the mortar. In the limestone mortars tested this point seems to be about the 1 : 2 mix.

7. The pass-40 limestone in mortar seems to have a "lubricating" effect which makes the mortar easy to work, promotes proper mixing, and insures a denser mortar.

8. On account of the inherent method by which they are produced, crushed materials for fine aggregate approach much more nearly the ideal granulometric analysis than do any natural sands.

General Summary

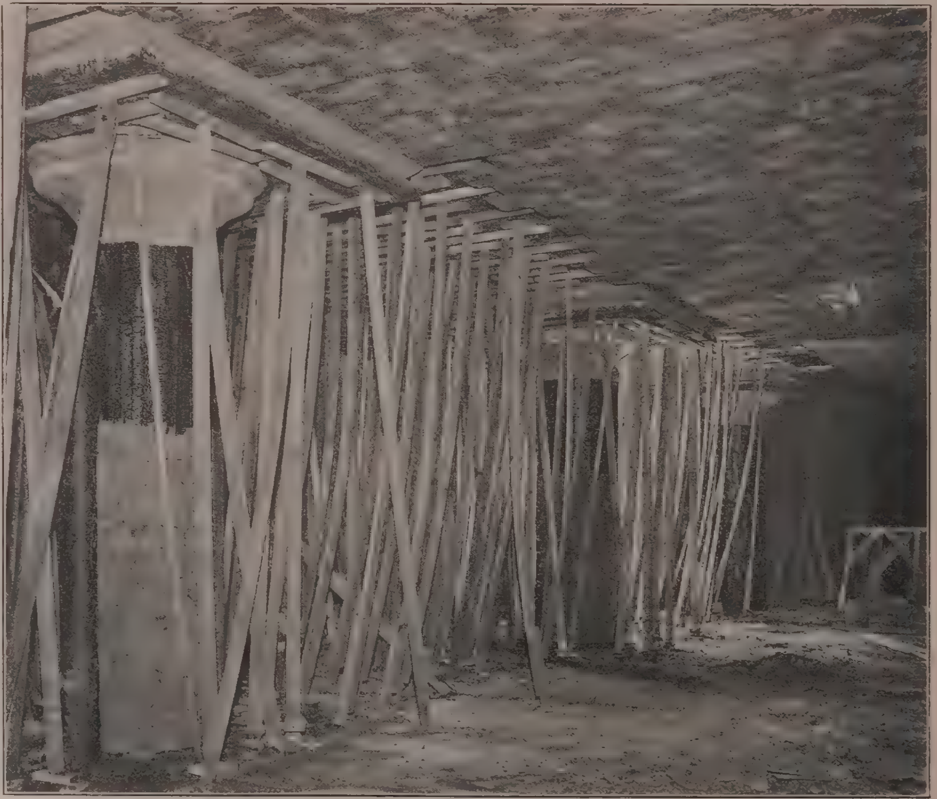
A new material is herewith proposed for Portland cement concrete consisting of four ingredients instead of the customary three. These four are (a) coarse aggregate; (b) coarse particles of the fine aggregate; (c) very fine particles of the fine aggregate, which are to be mixed independently with the cement; (d) cement.

Insulate Huge Concrete Building for Cold Storage

Concrete Columns, Flat-Slab Ceiling, Floors and Walls Inclosing Space of 5,500,000 Cubic Feet to Be Covered with Cork

Demand for cold-storage facilities in Chicago has recently increased so rapidly that 5,500,000 cu. ft. of storage space in the freight terminal of the Minneapolis, St. Paul & Sault Ste. Marie Railway are now being insulated and fitted up with the necessary cooling machinery. The building fronts on Twelfth Street, is a block wide and five blocks long and was described in the Engineering Record of Aug. 16, 1913, page 188. The ground floor space under the 2½-ft. slab and part of the ground floor under the four-story terminal building at the north end are to be used.

Insulation of a concrete building of this magnitude some time after construction has not been attempted heretofore, and some of the construction methods are novel. Applying the two layers of 3-in. cork board to the flat slab ceiling was preceded by chipping the whole surface with hammers having a 1½ x 2-in. corrugated face. Although the men doing this work were provided with goggles they had to be relieved at short intervals. They were each able to chip an area of about 20,000 sq. ft. per 10-hr. day. The ceilings were then washed down with water and acid. The Nonpareil cork boards, made by the Armstrong Cork Company, are each 12 in. wide and 36 in. long, and have corrugations in the back. Portland cement mortar of 1:2 mixture using sharp torpedo sand is applied to the back of the board in a ½-in. layer, and the board pressed against the ceiling and held there for 72 hr. by a 2 x 4-in. prop, a strip being placed lengthwise of the cork slab to support it the whole length. The cork boards are placed in two



SCANTLINGS SUPPORT FIRST CORK BOARD LAYER BUT SECOND SET IS SKEWERED ON layers for the purpose of breaking joints. The second set is secured to the first with six ¼ x 6-in. hickory skewers in each board, but the ½-in. cement mortar coat is not omitted.

The round columns and flared heads were covered by cutting the cork board in 3-in. strips and securing the "lagging" by wires. Partitions of brick divide the rooms into the maximum sizes permitted by the underwriters' regulations. The partitions and the floor are covered in the same manner as the ceiling, but over the top floor layer is placed a concrete wearing surface 3 in. thick in the center of the room and 4 in. at the sides to give drainage.

Four rooms of 100,000-cu. ft. storage capacity each are the first to be insulated and are to be used as the sharp freezers—that is, the temperature will be maintained at zero—hence the great care required to insulate every exposed surface, even the columns. For these rooms 500,000 sq. ft. of cork board was used and for the whole plant 3,000,000 sq. ft. will be required. Longitudinally through the structure is a central driveway. Railroad tracks run up to Fourteenth Street and from that street north 2½-ton electric trucks will be used to handle the goods. From the elevated tracks elevators are to be installed to lower the goods directly into the cold storage rooms.

The Westerlin & Campbell Company, Chicago, are installing the refrigerating machinery for the Chicago Cold Storage Warehouse Company, lessees from the terminal company. The Union Insulating Company is doing the insulation work.

Local Organizations Must Lead in Engineering Publicity

National Societies Are Necessarily Conservative—Their Branches in Each Community, However, Should Affiliate

LOCAL SOCIETIES, it was contended by A. J. Himes, valuation engineer of the New York, Chicago & St. Louis Railroad, in an address on Nov. 9 before the Cleveland Engineering Society, can by suitable publicity strengthen their own organizations and by their increasing influence and power arouse interest in the national engineering societies and stimulate their growth. Mr. Himes was speaking on the "Future of the Engineering Profession," and felt that in that future the local engineering society is to play a very large part. For that reason he discussed the means of increasing the influence of local bodies. He advocated, first, affiliation between local branches of the national engineering societies and, then, the use of publicity methods to bring home to the public the importance of the work of the engineer.

The following paragraphs from his address present strikingly the important points urged:

ADVERTISING

Advertising is a very old, conservative, well-tried, respectable and successful device for stimulating business. Is it less fitting that we should acquaint the public with the merits of our wares by description and explanation in print than that we should utilize paper and ink in our computations? Does an inventor bury his product in the earth less perchance some poor unfortunate shall look upon it and be saved? What does the Bible say about hiding one's light under a bushel? It is a barbarous idea that, locked in the secrets of his heart, a man should take with him to the grave knowledge that might be useful to his survivors.

This society has been advertising three years. Look at the record. Does it pay? The increase of membership has been 48.1 per cent. The increase of assets has been 37.7 per cent. Have we suffered in prestige or reputation?

On the contrary. The eyes of the country are upon us, watching our success and eagerly seeking to imitate it.

Assuming it is agreed by the profession to advertise, we arrive immediately at the practical question of intersociety relations. *There must be co-operation.*

CO-OPERATION

The public does not quickly sense the fine distinctions between engineers of different kinds and grades. It has neither patience nor ability to differentiate their needs. *In their relations to the public all engineers should stand together.* For this reason it is well that the local society should, within its field, marshal the full strength of the whole profession. Its local standing will be higher. Its interests will receive greater attention and consideration than would be possible if it were broken into several units representing different branches of engineering.

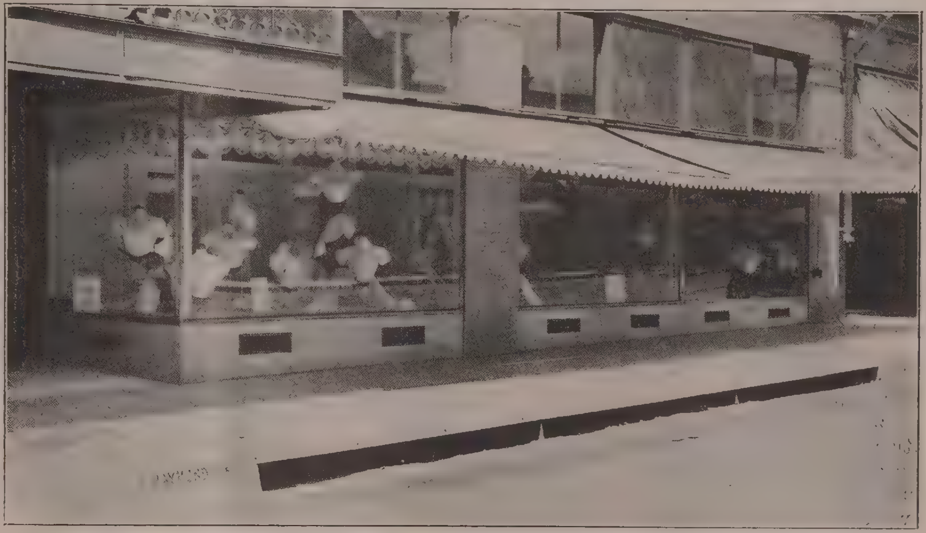
The preparation and utilization of advertising matter is so laborious and expensive that matter once prepared should be available everywhere. In this way, if all local societies were interested, the unit cost would be a minimum.

The national societies do not seem to be in a condition to join in such an undertaking. They are ultra-conservative, and not inclined to coalesce. The function which they have filled so well in the past, of stimulating the publication of papers and their discussion and of conducting engineering investigations, is of prime importance and should be continued. As organizations there is small hope of aid from them in publicity affairs.

The increase of membership in local societies consequent upon a publicity campaign would undoubtedly increase the interest in national societies and stimulate their growth. For stability the growth must be from the bottom up, and a more lively local interest in engineering would add greatly to the power and influence of the national societies. If it were possible to combine all national societies in a single organization that in matters of legislation and public policy would represent the whole profession, the ideal condition of strength might thus be attained.

Street Flooding Prevented by Wide Storm-Sewer Intakes

THE PROBLEM of handling large volumes of storm water in street gutters without flooding the crossing for pedestrians has been solved in Pasadena, Cal., by the use of long sewer intakes located in the curb adjacent to the street intersections. As shown in the accompanying illustration, the intakes are made 30 ft. long, with a 9-in. opening. The sidewalk slab over the intake is of reinforced concrete, 3 in. thick and supported at the curb line on two steel struts.



SEWER INTAKE THAT LEAVES CROSSINGS HIGH AND DRY

The normal flow line of the gutter is lowered 3 in. and at the end of the intake away from the street intersection this difference in elevation is taken up in a length of 6 ft. At the crossing end, on the other hand, the gutter level is raised to within 2 in. of the sidewalk level at the point where pedestrians cross. This affords a smooth intersection and a "high and dry" crossing, even in times of heavy storms.

The intakes were designed by R. V. Orbison, city engineer of Pasadena.

A CENSUS OF PEDESTRIAN TRAFFIC on State Street, Chicago, recently taken by owners of the newly erected Republic office building indicates that there were 327,710 people passing on State Street in one week, and nearly 200,000 on Adams Street. The relative number of men and women were about equally divided on State Street, but on Adams Street there were 145,000 men. The count was made only between 8 a. m. and 6 p. m. and was limited to those passing along the sidewalk adjoining the building. As this corner is at the center of the seven busiest shopping blocks in Chicago the figures may be of value to engineers and contractors contemplating any construction which would interfere with this weekday State Street stream of from 50,000 to 60,000 persons. On Sunday the number dropped to about 5500 on both streets.

Powers and Duties of the City Manager Defined

H. M. Waite Epitomizes Principles and Relations with the Public at the City Managers' Convention at Dayton

THAT cities will be governed precisely as well as citizens deserve and desire, and that the city-manager form of government is the nearest approach yet attempted to the ideal government are two of the principles laid down by H. M. Waite, city manager of Dayton, at the second City Managers' Convention held Nov. 15 to 17 in that city. Other terse, almost epigrammatic terms used by this engineer now holding the highest executive position in Dayton are given here, because they seem to indicate the frame of mind the engineer must develop if he is to hold successfully a similar position.

Any step toward a more centralized government is an improvement. Successful government must have the continued support of the majority. Good government can advance and improve only so far as the majority of the citizenship is able to appreciate and understand it. Therefore, the ideal government can be approximated as nearly as the majority of the people is able to appreciate and understand it.

The rivalry of communities may lead to the acceptance of a government of too centralized a form to be appreciated by the citizenship. Each community should approach the ideal only so far as the local conditions make it desirable. Each step toward centralization of authority will bring improvements in government and thus the citizens will be gradually prepared for the ideal. The ideal, however, should never be accepted until the large majority of the citizenship is ready to eliminate partisan politics from their municipal affairs, and keep it eliminated.

Men of large affairs demand broad authority. Broad lines of authority develop and attract capable executives. Broad authority carries responsibility. Responsibility attracts executives and imposes on them caution. Executives with broad authority, and using caution, accomplish results.

Communities that, for any reason, cannot give broad authority to the executive, are not ready for the ideal and should accept a more modified centralized authority—and not call it a city-manager form. The executive in the ideal government should have full authority in the administration of government and be held responsible for it. Lack of authority permits excuses and explanations, but clean-cut authority gets clean-cut men and clean-cut results. To get the maximum power and efficiency from the city manager he must be given the maximum authority.

THE CALIFORNIA RAILROAD COMMISSION between March 23, 1912, and May 31, 1915, authorized the issue of public utility securities to the amount of $426,983,980. A large part of the securities thus authorized were for refunding purposes, but the total amount authorized for the construction of additions and betterments has amounted in this period to $239,790,155. The investment which has been made in California as the result of these issues is greater than the investment made by public utilities during any other corresponding period in the history of the State.

THIS IS AN EXAMPLE OF A ROLLED ROADBED WELL SHAPED

Experiment with Gravel Roads in Iowa

T. R. Agg Tells Details of Preparing Roadbed, of Rolling, of Removing Waves in Gravel, and of Necessity for Early Maintenance

IOWA has been experimenting this summer with gravel roads and in the November *Service Bulletin* of the State Highway Commission, T. R. Agg, professor of highway engineering of the Iowa Engineering Experiment Station, recounts the methods used and the results obtained as follows:

While the season was an exceedingly bad one for construction work, it being almost impossible to secure strictly high-class results, neverthless it is believed that the general method followed will prove entirely satisfactory for most Iowa graveled roads.

While it is highly desirable to secure a gravel containing about 60 per cent of material retained on a ¼-in. screen and having from 15 to 20 per cent of clay binder mixed with it, the summer's experience indicates that a good road can be built with any kind of gravel if it be properly handled. On the Fort Dodge road, carrying successfully the exceedingly heavy traffic of the Hawkeye highway, the gravel consisted of pebbles ranging from ½ in. in size down to fine clay. The clay content was about 20 per cent and only about 40 per cent of the material was retained on the ¼-in. screen. The pebbles were of good, hard durable material, and the clay was thoroughly mixed with the sand.

On the Spirit Lake work, several different supplies of gravel were drawn upon. Some of the material was exceedingly coarse, contained pebbles up to 3 in. or more in size and was deficient in bonding material. Other material that was used ranged from about 2 in. down, was fairly well graded and contained about 15 per cent of bonding material.

At Rockwell City an exceedingly variable local deposit was used. The gravel contained at least 60 per cent of sand and 20 to 25 per cent of clay.

Whatever the character of the material happens to be, good results can be obtained if care be exercised in securing uniform mixing of the materials on the road so that the layer will be homogeneous in character and will, therefore, wear uniformly. It is also important to rake out the larger stones and put them in the bottom layer. This was particularly noticeable on the Spirit Lake work. On some of the older roads in that vicinity, the surface was exceedingly rough, due to a lack of uniformity in the gravel, and particularly to the presence of stones larger than 2 in. in diameter. It is believed that no stones larger than will pass a 2-in. ring should be used for the wearing course of a graveled road. If the gravel is deficient in binder, clay or loam from alongside the road can be added to the surface and harrowed in, but care should be taken not to use too much binder.

PREPARATION OF ROADBED

In shaping the trench for the lower course several methods were tried out, some of which did not prove to be very satisfactory. The elevating grader with a short horizontal apron, was used for a few days and apparently will prove to be very satisfactory for this class of work. The material which was excavated in forming the trench for the lower course was delivered

THE LARGER STONES SHOULD BE RAKED IN SUBGRADE AHEAD by the apron far enough out at the side to form the shoulders for the upper course. Unfortunately, the machine that was being tried out broke down before conclusive ideas had been arrived at as to the exact manipulations necessary to complete a roadbed by this method. Later, the trench for the lower course was plowed by means of the tractor and a heavy road plow, and the material thus loosened was graded out to form shoulders for the upper course by means of a blade grader. This method did not prove to be very satisfactory, because the tractor repacked the material that had been loosened during the plowing, and it was difficult to finish the grading without additional plowing. At another place, the heavy scarifier was used to loosen the road surface, and after it had made a few rounds, the loosened material was graded out with a blade grader for shoulders. Probably the following methods can be used satisfactorily: 1. Elevating grader with horizontal apron. 2. Scarifier and blade grader. 3. Road plow and blade grader, if each furrow is graded out as soon as plowed.

ROLLING THE ROADBED

After the roadbed has been shaped it is thoroughly rolled with a roller weighing at least 10 tons. The purpose of the rolling is twofold: 1. To compact and seal the roadbed so as to make it as nearly waterproof as possible. 2. To develop any fundamental weaknesses in the foundation if such exist. These latter will be evident by spongy places that will not compact. When such places exist before the gravel is placed and are not discovered the gravel road will eventually develop a depression at this point. Probably it will cut through. The cause of spongy places is usually water, either held in a pocket surrounded by impervious clay, or underground water flowing near the surface. In any case it is important to discover the presence of poor foundations before the gravel is placed and to take whatever measures are necessary to correct the condition before placing the surface.

Experience has shown conclusively that one cannot regularly compact a layer of gravel that is more than 6 in. thick. For that reason a gravel road should be constructed in two layers, each of which will be about 6 in. thick before compacting. When the road is built to the Iowa Highway Commission standard the lower course will be 8 ft. wide.

GRADER SHOULD REMOVE WAVES BEFORE FURTHER ROLLING

CRACKS ON THE SURFACE DISCLOSE SPONGY PLACES IN THE SUBGRADE

In order to get just the right amount of material in the roadbed the wagon should be measured and the distance should be computed. The dumper should then be given a stick of the length that a load should spread or should be given a cord of the right length with a stake at each end. If the loads are dumped the right distance apart spreading is considerably easier and when completed the builder is assured that he has the proper thickness of gravel. The spreading may be done with shovels or with rakes as fast as the loads are dumped. But if the hauling is being done by a large force it may be more convenient to dump a number of loads of gravel and then spread them with a blade grader. For this work a light grader that can readily be drawn by two horses is better than a heavier machine.

HARROWING MIXES MATERIAL EVENLY

After the gravel has been spread it should be thoroughly harrowed to evenly mix the material. Everyone knows that the ordinary gravel is exceedingly variable in composition, and that even material hauled from a single pit will vary from load to load. If, however, the material in the road is thoroughly stirred up a sufficiently uniform texture can be secured to give reasonable uniform wearing qualities. The harrowing has another important function, that is, to distribute thoroughly the bonding material through the mass. This bonding material is often clay from the overburden, or from dirty gravel, that is mixed with the better material. Sometimes it is clay that is thrown upon the surface from alongside the road.

The most satisfactory harrow is one that is made of 1¼-in. round iron, spaced about 6 in. apart and extending 8 in. below the frame. The harrow is arranged to be drawn by one corner and weighs about 250 to 300 lb. The teeth must be long enough to stir thoroughly the entire thickness of the layer.

After the gravel has been spread and harrowed it is rolled once over. At this stage it will have a wavy appearance due to the fact that in spite of the utmost care there is a lack of uniformity in the spreading and some difference in the density of the layer of gravel. The blade grader is run over the surface dragging the high spots and depositing the material in the low places. Two or three rounds are necessary to produce the desired uniformity. It is important, however, to take very light cuts with the grader, dragging only a small amount of material along the surface. When once the blade is set it should not be shifted again during the round, otherwise additional uneven places will be formed. The roller is then run over the surface for another round or two and the grader again used to smooth the inequalities. On the work done during the past summer it was usually found necessary to repeat this operation four or five times. But this was due to the unusual weather conditions which made it impossible to secure as favorable a foundation as would ordinarily be the case. Probably during an average season, three times over with the grader between rolling will be enough.

The important thing is to get the gravel so well spread that it rolls down uniformly. As soon as this stage is reached the rolling is carried on continuously until the layer is thoroughly compacted. If the gravel has been placed during dry weather and continues to dry out after being placed on the roadway it is useless to attempt to compact it with a roller or by any other means. It should be kept in shape by frequent trips with the grader until a rain wets it sufficiently to permit rolling. This may be a considerable time at certain seasons of the year, but if the gravel has been spread between suitable earth shoulders the traffic cannot spread it out over the roadway and waste it during the period when it is too dry to pack. When it does receive enough water to pack properly the roller will finish many feet of road a day. During the period when the road is being kept in shape the grader should be used in preference to the drag. The drag has a tendency to increase the waviness of the surface unless provided with runners.

EARLY MAINTENANCE PREVENTS RUTS

No matter how carefully a gravel road has been built it will not be possible to produce the stability and density of texture that would result from years of traffic. During the first year especially traffic will have a tendency to form ruts or depressions in the road surface. Unless these are taken care of immediately upon their appearance they are liable to become a permanent feature of the surface. As the gravel gradually seasons it becomes increasingly difficult to remove depressions or ruts and the economical thing is to prevent the formation of them. This is best accomplished by an occasional trip with a light blade grader until the road reaches that stage where the blade will not touch the surface. After that the plank or split log drag should be used. The drag will not shave the surface but will collect a little loose material as it moves along, and this will be sufficient to fill the small ruts and depressions that may have formed. It should be expected that during the first year the road will need constant attention. After that time it will need occasional maintenance so long as it will be used.

Many miles of gravel road have been inspected during the past season that were really dangerous for automobile travel because of the excessive cross slope. The gravel had been placed on an earth road surface which was itself crowned too highly. The gravel added another 8 or 10 in. to the crown and no shoulders were brought up to the edge of the gravel. These roads were comfortable enough to travel so long as the car was straddling the crown of the road. But if compelled to turn off to the side it was not only very uncomfortable to travel but positively dangerous when the earth side road was wet.

From the cost data obtained at Fort Dodge and on the part of the other experimental roads not yet completed, it is believed that serviceable double-track gravel road can be constructed for $2,500 per mile, where the haul for gravel does not exceed 2 miles and where gravel can be obtained at not to exceed 50 cents per yard.

Publicity Necessary for City Manager Success

Topic Received More Attention at Dayton than Any Other Subject—Managers Declare It Their Greatest Problem

UNLESS constantly supported by the public the city-manager form of government is in grave danger of failure because of its vulnerability to attack by politicians. Its "raison d'etre" is the higher efficiency theoretically obtainable under concentrated control. Yet that control necessarily centers on a single individual all the criticism and complaints that can arise in the manifold activities of a city. Consequently the city manager needs to secure the greatest possible publicity for his actions and policy, for only the truth can furnish an adequate defense against attack.

For these reasons publicity received more attention at the convention of the City Managers' Association in Dayton last week than any other one subject. The principal paper on the topic—describing the publicity policy at St. Augustine, Fla.—was read by Winton Miller, city manager of that place. The following paragraphs give the main points of his paper.

Quality of Publicity Matter

All publicity matter given out must be dignified, clear, concise. Although promises should not be made where it is possible to avoid making them, it is well to take the public into confidence in all matters pertaining to public policy, so as to get before the citizens proposed plans and activities and to give the administration a line on the sentiment of the community with regard to them.

Many officials do not have a knowledge of news value. Appreciating this we have followed the practice established in Dayton of having all correspondence for a day remain in an open file basket in each office until noon of the following day, that the representatives of the press may read all such correspondence and thereby tips. The reporters follow up these tips with interviews in order to get explanations and more detailed information.

Outside Agencies

It is better, too, that publicity should come from other than official sources and it is essential to have some agency pledged to give the public accurate, unbiased information regularly as to the activities in the City Hall. In this the bureau of municipal research is most valuable in cities of sufficient size to support such an institution.

Another agency is the organization known as the Citizens' Committee, Good Government Club, Civic Society, or what you will, devoted to the principle of efficient municipal administration. The function of this organization should be, first, to send out through the press or by pamphlets material showing how the city's affairs are being handled.

Municipal exhibits are most effective in bringing home to the taxpayer and citizen the advantages of the new form of government, to show the actual advantages, particularly of the new functions being taken up by the administration.

The second function of the citizens' committee is that of maintaining a good-sized organization of workers pledged to keep posted on civic affairs, so as to keep the community spirit up to a point that will insure the maintenance of good administration.

Advisory Boards

As a means of getting the formal cooperation and advice of citizens, of assisting in the general scheme of increasing confidence in the government, and of getting wider publicity for the details of the various departments, advisory boards have been appointed on various matters, including finance and taxation, waterworks and fire, park and public land beautification, city planning, and garden development and playgrounds. Each department with which these boards come in contact may soon demand increased revenues and it will be necessary to give the public reasons for these increased demands. The personnel of these boards affords a means of direct publicity.

Personal contact is a strong factor not only in getting before the people matters of interest to them, but of keeping down to a minimum any state of dissatisfaction or unrest. In order to develop the personal factor in St. Augustine, Monday night of each week is given up by the manager to holding "open house" for receiving citizens. In this St. Augustine is not a pioneer, as the manager of Springfield, Ohio, was the first to establish this open-house policy in the new form of government. These open houses have been most beneficial. It gives the citizen a more direct voice in the government. It places him in closer contact and affords a better acquaintance with municipal activities. It provides the man with a hobby the means of getting his suggestions directly before the officials. It gives the man harboring a complaint a chance to get the kick out of his system. It gives the officials a closer line on what is going on around the town.

FORTY-SIX STATES now have commissions for regulating public utilities, according to information assembled by Louis Roth and published in the New York *Public Service Record.* The only States without them are Delaware and Utah. The oldest existing commission is that of South Carolina, created in 1878; the youngest is that of Wyoming, established this year. The earliest railroad commission on record is that of New Hampshire, created in 1844.

How Apportion Costs of Municipal Improvements?

Nelson P. Lewis Discusses Relative Local and General Benefits and Proposes Rule Applicable to New or Widened Streets

A PHASE of city planning discussed at some length by Nelson P. Lewis, chief engineer of the Board of Estimate and Apportionment, New York City, in his International Engineering Congress paper on that subject, but only touched upon in the abstracts already presented in this journal (see the issues of Sept. 25, page 382, Oct. 2, page 415, and Nov. 13, page 597) is that of the distribution of expense for various classes of municipal improvements. Some classes he would assess entirely against the abutting owners. Others bring general as well as local benefits, and should be assessed accordingly. The rule he proposes for new or widened streets assumes the percentage of local benefit to depend on the width of the street. As to parks, the benefits vary more or less inversely as the distance therefrom. The following are Mr. Lewis' views substantially as he expressed them:

If the property in the neighborhood of a new park, public building, rapid-transit line or waterway is to be increased in value by some act of the city, and if the owners of this property are to be enriched by this act, is it fair or just that these owners shall contribute no more per unit of assessed value than do the owners of other property more slightly, if at all, affected? To determine the precise amount of benefit will be well nigh impossible, but the recognition of the fact of the benefit and of the obligation to pay a special share of the cost in return for that benefit seems only a question of elementary justice.

Relative Benefits from Street Changes

In the case of local streets, the purpose of which is simply to furnish light, air and access to the abutting property, that property could fairly be required to pay the entire cost of the acquisition and improvement of the street. When a highway is given a more generous width in the expectation that it will be called upon to accommodate a certain amount of through traffic, the benefit is more general, and the assessment area in such a case may be extended to a line midway between it and the next street of more than residential width. The major part of the expense should, however, be confined to the abutting property, so that the cost to it shall be somewhat more than that of the narrower street. In the case of arterial thoroughfares, or in the case of the first street to be opened through an undeveloped territory, the effect of which will be to give access to and stimulate the development of a large district, the area of benefit will be correspondingly enlarged. Again, in the case of thoroughfares of exceptional width which it is proposed to treat as boulevards or parkways, the entire city or metropolitan district will be substantially benefited and should bear a portion of the expense.

In the case of street widenings or the cutting of new streets through built-up sections, the local benefit is less marked, though it will always follow. The mere fact that a widening or extension is required to accommodate traffic is conclusive evidence that the street has assumed more than local importance. The width of the road as widened is not an index of its local or general importance. There may be cases where the opening up of a new street of a width commonly given to local streets and extending for a very short distance would, on account of its strategic position, be of great general and of little local benefit. The relative local, district or general benefit resulting from any street or other improvement can be determined neither by its dimensions nor its cost. An improvement involving the expenditure of $1,000,000 in one part of the city may be more distinctly local in its beneficial effect than one costing $50,000 in another section.

Rule Fixing Local Benefit

While no definite rule can be adopted to govern the distribution of assessments representing the local district or general benefit, it should be possible to prescribe a method of determining the amount and extent of the local benefit, particularly in the case of new streets, boulevards and parks. Let us assume that 60 ft. is the maximum width required for a local street. Then the entire cost of acquiring and improving all streets 60 ft. or less in width may properly be placed upon the property within a half block on either side of the street. In the case of wider streets that proportion of the cost represented by the ratio which 60 ft. plus 25 per cent of the excess over 60 ft. bears to the width of the street would probably be an equitable proportion to assess upon the local district. Up to a certain limit property fronting a wide street is more valuable; on the other hand, after a street reaches a certain width additional width will not involve additional benefit. It may be assumed that the share of the expense which would be equivalent to paying for a street 80 ft. wide should represent the limit of local assessment. This limit would be reached under the proposed rule when the street becomes 140 ft. wide. The percentages of cost which would be locally assessed would, therefore, be as follows for various street widths:

Width, feet,	Percentage,
60 and less	100
70	89.3
80	81.25
90	75
100	70
150	53.3
200	40

In the case of street widenings involving the destruction of buildings, the same general principles might be adopted as in the case of new streets, but they should apply to the land values only. If the street were less than 60 ft. wide the proportion of expense for the additional land in order to make it 60 ft. would be assessed upon the half block on each side, while for all excess over 60 ft. the same rule already proposed could be adopted. For instance, if a street 50 ft. wide were to be widened to 80 ft., involving the acquisition of 30 ft. of additional property, the first 10 ft. required to make it 60 ft. wide and 25 per cent of the 20 ft. over 60 ft., a total of 15 ft., or one-half the cost of the additional land to be taken, might be assessed locally, the expense involved in damage to buildings being included in the district assessment or in the general assessment if the improvement is of sufficient importance to involve general benefit.

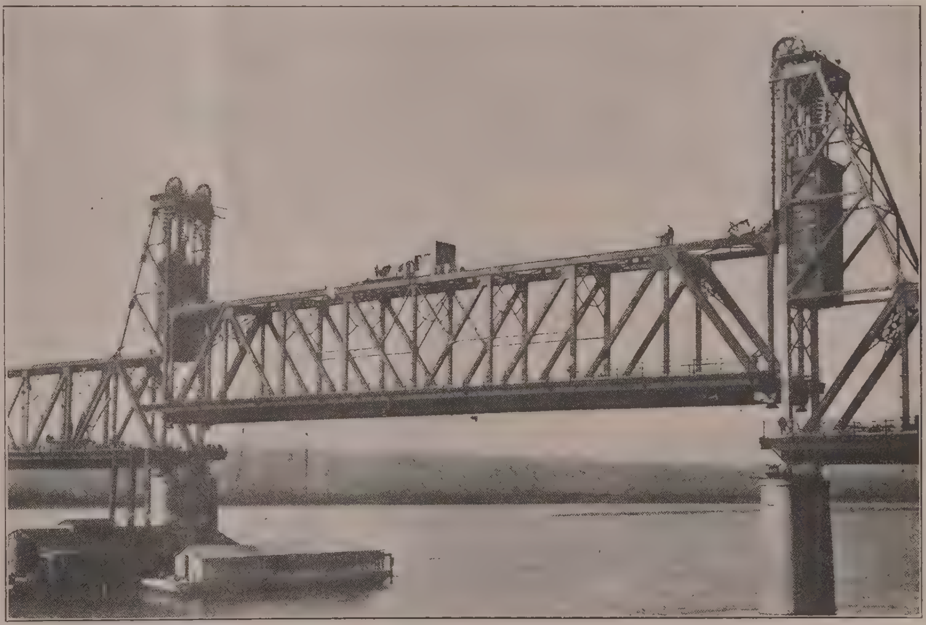
Park Problem More Difficult

In the case of parks the problem is more difficult, the amount of local assessment and the extent of the area of local benefit being determined by the size and shape of the park and facility of access to it from other parts of the city. In any case, no rule should be adopted until it has been carefully tested, and has demonstrated that the assessment levied in accordance with it will constantly decrease as the distance from the improvement increases. A curve to determine the distribution of the assessment after the limits of the district have been decided has been proposed by Arthur S. Tuttle, deputy chief engineer of the Board of Estimate and Apportionment of New York City, in accordance with which about 32.5 per cent of the assessment would be placed upon the first 10 per cent of the distance to the outer limit of the area of benefit, 55 per cent upon the first 25 per cent and 80 per cent upon the district extending halfway to the outer boundary of the area of benefit.

Lift Spans Over Arkansas River Designed for Possible Shifting of Channel

Bridge Near Pine Bluff, Arkansas, Contains Unusual Lifting Mechanism—Chains Instead of Cables—Folding Counterweight

PROVISION for a shifting river channel by using a lift span and five other truss spans of identical design to make possible future transfer of the towers to lift any span desired, the use of counterweight chains of special design instead of the usual wire cables, and the adoption of a folding cast-iron counterweight to control the balance of the lift span and chains are some of the unique features in the recently completed bridge over the Arkansas River near Pine Bluff, Ark. This bridge, which is a combined railway and highway structure, was built by Jefferson County, Arkansas, and crosses the Arkansas River about 4½ miles upstream from Pine Bluff. It was considered advisable to provide for railway traffic in order to furnish a crossing for certain proposed railways, none of which have yet been built.



LIFT SPAN OVER ARKANSAS RIVER WITH LINK CHAINS TO COUNTERWEIGHTS

The bridge is approximately 3010 ft. long, with 1610 ft. of steel structure and 1400 ft. of timber trestle. The steel section consists of seven riveted spans, six of which are 239 ft. 4 in. center to center of end pins, while the one at the north end is 149 ft. 7 in. long. The six long spans each have eight panels and the short span has five panels, all of the panels being 29 ft. 11 in. in length.

Loads and Allowable Stresses

The live loads used in the design of the superstructure were Cooper's E-50 loading for the railway track, a 10-ton motor truck or 100 lb. per square foot for the roadway floor, and 50 lb. per square foot on the roadways for the trusses. The piers were designed for Cooper's E-45 loading on the railway track and 30 lb. per square foot on the roadway. The impact increments were computed by the following formulas:

For railway loads

$$I = \frac{800}{800 + L + L^2/100}$$

and for highway loads

$$I = \frac{300}{800 + L + L^2/100}$$

where I is the impact increment, and L the loaded length in feet.

The allowable working stresses were specified according to usual practice, except that 17,000 lb. per square inch was allowed for eyebars and laterals in tension, 12,000 for floorbeam hangers, and 16,500 for the extreme fiber stress of plate-girder flanges when computed by the moment of inertia method. Built members having lacing bars were allowed a unit stress of $14,000 - 60l/r$, or less than the $16,000 - 70l/r$ used for stocky members with solid web diaphragms. Jaw plates or forked ends of compression members were allowed $10,000 - 300l/t$, the value l/t not to exceed 16.

The channel of the Arkansas River is liable to shift at any time. At the Cotton Belt bridge, a few miles below Pine Bluff, the channel shifted from one side of the river to the other, necessitating the construction of a new swing span, so that the bridge now has two swing spans. It was therefore considered desirable in this case to use a type of construction such that the movable span could be shifted to any part of the bridge in case of a change of the location of the channel. This requirement, it was thought, would be best met by the use of a vertical lift type of movable span.

The War Department required a clear channel of 225 ft. between piers and a vertical clearance above high water of 60 ft. when the lift span is raised to full height. This fixed the span length at 239 ft. 4 in. The channel at present is near the north bank, and the five spans to the south of the channel spans were also made of the same length.

ALL TRUSSES ALIKE

The lift span, of course, acts as a simple span under live load, and the members are stressed precisely the same as the corresponding members in the other spans, except that they carry a small additional stress due to the operator's house and weight of machinery. The trusses of all six spans were made alike to provide for this extra loading in case some other span should be converted into a lift span. In case it is necessary to change the location of the movable span, the towers, counterweights and operating machinery will be moved to the desired point, holes being provided in all spans for this purpose.

The weight of the lift span is counterbalanced by concrete counterweights attached to the span by means of steel chains passing over cast-steel sheaves or drums at the tops of the towers. Hence the shoes at the ends of the lift span carry no dead load, the weight of half the span being transferred to the two columns of a tower. Since one of the counterweights weighs the same as half the span, the total dead load at the top of the tower is equal approximately to the weight of the span, which is 610 tons. Consequently the shoes of the tower, which must be fixed, carry a much heavier load than the other shoes.

DESIGN OF SHOES TO ALLOW CONVERSION

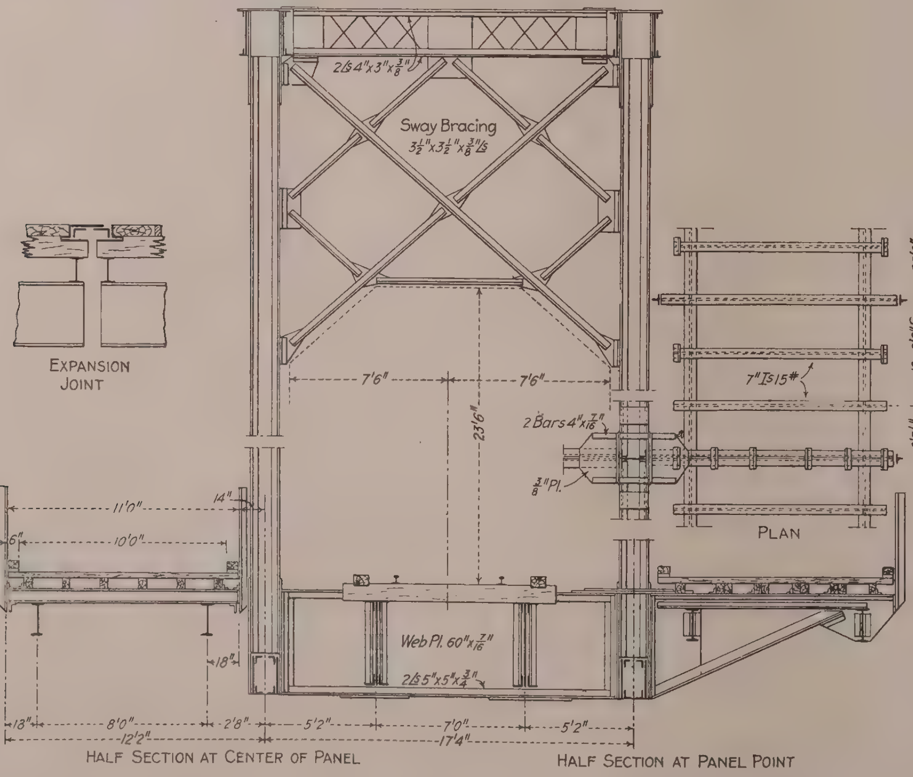
In each span there is a fixed end and a movable end, so that in case of the conversion of another span into a lift span it will be necessary to change two roller shoes into fixed shoes and vice versa. The shoes are so designed that the rollers may be removed and a steel casting of the same depth inserted. Each roller nest consists of seven 8-in. rollers, which have a 2½-in. groove at top and bottom in which fit longitudinal lugs on the shoes and bedplates. In the case of the lift span, this lug in descending might strike the edge of the groove and thus prevent the span seating properly. For this reason the lug at the base of the shoe is made removable and is omitted in the lift span.

Both the fixed and the expansion shoes of the lift span are carried up with the span. The rollers are left on the base or pedestal, and are kept approximately vertical by means of two coil springs attached to the top of the middle roller at one end. These springs are attached to the ribs of the cast-iron base in such a manner that they pull in opposite directions, thus keeping the rollers upright.

In order to provide for the heavy load transmitted by the tower columns at the ends of the adjacent trusses, steel castings are used between the end gusset plates. These castings are riveted to the gusset plates so as to transmit the reactions of the trusses to the shoes, and the loads from the tower columns are transmitted directly through them to the end pins. These castings are provided at all the end pins, since it is not known what shoes will be called upon to support the tower load.

The lift span is provided with guides to insure its proper position while ascending and descending. To special end struts are attached, by means of turned bolts, steel castings projecting into the rectangular space formed by the web and flanges of the 14-in. Bethlehem H-section of the tower posts and the flange angles riveted to the inside of the 22-in. side plates. At the fixed end of the span each of these steel castings has two longitudinal rollers, and one transverse roller on its center line beveled to suit the inclination of the under side of the flange of the H-section. Thus the span is effectually guided both longitudinally and transversely. At the expansion end of the span the two longitudinal rollers are omitted so as to provide for the expansion and contraction. The rollers are designed so as to be easily removable.

SPAN LIFTED TO HIGHEST POSITION



CROSS-SECTION OF BRIDGE—CANTILEVER BRACKET CONNECTED TO FLOORBEAM

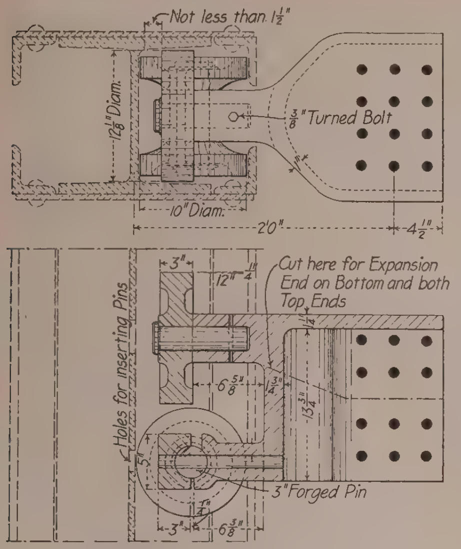
The lift span when in position for carrying traffic is practically suspended in the air, since the shoes carry only the live load. In order to resist the longitudinal thrusts due to braked trains, two castings are provided, one attached to the tower post and the other to the lift span. The casting attached to the lift span has a tongue which engages a recess in the other, preventing the longitudinal movement of the span.

In order to center the span transversely there is attached to the middle of each end floorbeam of the lift span a casting with a tongue which engages a recess in another casting carried on a steel frame attached to the pier. This device also serves to carry the transverse wind load to the pier, since it would be difficult to carry this load through the shoes.

COUNTERWEIGHT CHAIN

Perhaps the most interesting feature of the design is the counterweight chain used to support the span. Other vertical lift bridges are supported by means of wire ropes at each corner of the span attached to a series of horizontal equalizing levers for the purpose of insuring equal stress in all the ropes. There are a number of objections to this type of construction, and it was thought that the use of flat link chains would be preferable to wire rope.

These chains are built up of short links or bars connected by means of 3½-in. pins. The radius of the drum at the pitch line of the chain is 4 ft. 3½ in., and the links running over it are about 1 ft. 8 in. long, center to center of pin holes. The set of links between pins are made alternately rotatable and non-rotatable, with three rotatable links in each section. The heads are forged to a thickness of 4¾ in. so as to reduce the



DETAILS OF ROLLER GUIDES

bearing on the pins to 6000 lb. per square inch. These rotatable links are provided with bronze bushings ½ in. thick. In each set of non-rotatable links there are two inside links and two outside links. The pins project somewhat beyond the outside links and are provided in each end with a diametrical hole in which is inserted a 1¼-in. keeper bar, which is bolted to the center of the outside non-rotatable link. The purpose of the keeper bar is to prevent the rotation of the pins with respect to the non-rotatable link and compel the rotation to take place in the enlarged heads of the rotatable links.

No provision was made for lubrication; since the operation of such bridges is rather infrequent, it is believed that very little wear will occur. Even if considerable wear should take place it would not be a matter of consequence, since the operation of the chain depends in no way upon the pitch of the links, center to center of pins.

Bending of Keeper Bars

The keeper bars were designed to overcome a difference of about 2 per cent in frictional resistance. It was thought that the resistance to rotation of the bronze bushed links would be less than that of the thin unbushed links. In some instances this proved not to be the case when the span was put in operation, as rotation took place in the heads of the thin links, which caused the keeper bars to bend, and in some places to break.

It was observed that the bronze-bushed links were a rather tight fit, making it difficult to drive the pins, while the other links fitted somewhat more loosely. Most of the trouble developed on the approach of warm weather, and it seems probable that since bronze has a coefficient of expansion about 50 per cent greater than steel, the expansion of the bushings was sufficient, in connection with the close fit, to produce such a grip on the pins as to compel the rotation to take place in the set of links which were designed to be non-rotatable. The original keeper bars were made of medium steel. They have been removed and replaced with new pins of greater strength.

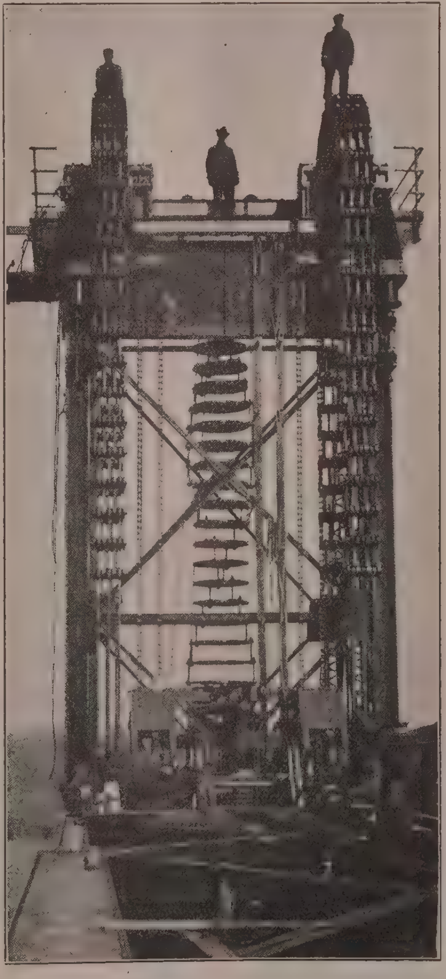
Folding Counterweight Controls Balance

The main counterweights are composed of precast concrete blocks supported in a steel frame. This construction was designed to facilitate the erection of the counterweights and permit of their being taken apart and moved if necessary.

Another feature is the cast-iron supplementary or folding counterweight. This auxiliary counterweight was provided in order to compensate for the transfer of the weight of the chain from one side of the drum to the other. It consists of cast-iron circular disks 3 ft. 5 in. in diameter and 2¼ in. thick, with projecting lugs diametrically opposite having two holes in each lug for 1¾-in. bolts. The upper disk or plate is suspended from the tower by means of two opposite bolts. The second disk from the top is supported from the top disk by means of two opposite bolts from the other pair of holes. The third disk is similarly supported, and each disk is rotated slightly with respect to the one above in order to permit the bolts to clear the lugs when the disks are brought together.

How Folding Counterweight Acts

When the main counterweight is in its lowest position the folding counterweight is extended so that all disks are 1 ft. apart in the clear. As the main counterweight rises when the lift span descends it picks up these disks one at a time until it reaches its highest position, when the folding disks are all superimposed upon one another and the entire weight rests upon the main counterweight. The weight of the disks is such as to compensate in all positions for the lack of balance of the main chain. Thus no power is required to overcome unbalanced loads except such an unbalanced load as may be due to the impracticability of determining the exact weight of the lift span or counterweights.

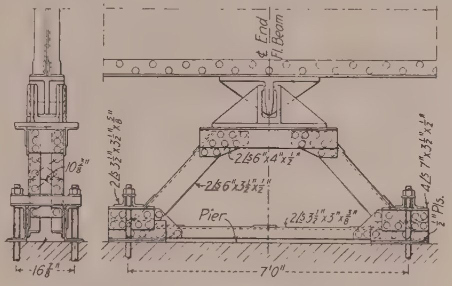


LATERAL CENTERING DEVICE FOR LIFT SPAN AND CONNECTION TO PIER

An auxiliary counterweight of this type might be designed to assist in operating the span. Thus, by changing the weight or spacing of the individual disks to secure an overbalance of weight on the counterweight side they would aid in starting the span upward when down, and a corresponding overbalance on the span side would start the span downward when up.

Operating Machinery

At each corner of the span there are two heavy sprocket chains attached at one end to the top of the tower and at the other to the cross girder between the tower posts a short distance below the top of the top chord. These operating chains are attached to horizontal links to equalize the stresses and are provided with bolts at top and bottom to adjust the position of the chains and to regulate the tension.



FOLDING DISKS PRESERVE BALANCE

At a point a little above the top chord each pair of sprocket chains is looped back toward the center of the lift span in a horizontal direction between two pairs of idler sprockets and then passes over drive sprockets. These sprockets are operated by a train of gears connected to a motor. There are two motors, one at each end of the span, each operating the two pairs of driving sprockets at that end. The train of gearing, the drive sprockets and the idler sprockets at the corner of the span are all attached to a structural steel frame, and all the parts were assembled and fitted before shipment from the shop.

In order to insure that both ends of the span move together, the mechanism of the two ends is connected by a line shaft. In case a motor at one end should get out of order, the motor at the other end will operate the span, the line shaft being capable of transmitting its power to the other end. To the line shaft is attached the hand-operating capstan near the center of the span.

Source of Electric Current

When the plans were prepared it was expected that the proposed electric railway from Pine Bluff would be built by the time the bridge was completed, and for that reason the span was designed to be operated by means of two 1200-volt direct-current motors rated at 40 hp. Since the electric railway was not built, a transmission line from Pine Bluff to the bridge site had to be constructed. As this transmission line carries 2300-volt aternating current, it was necessary to provide a motor-generator set to convert the alternating current into direct. It was found impossible to procure a 1200-volt motor-generator set without considerable delay, so a 600-volt set was installed and the current supplied is quite sufficient for operating the span.

The span is locked in position by means

of a heavy strut or beam which slides under a roller attached to the cross girder between the tower posts. The upper side of the lock at the end is provided with a beveled casting sloping 4 in. in 18 in., and the mechanism is designed so that in case the span should not be quite seated the lock will force it down to the proper position. It is operated by a rack and pinion actuated by a small motor with speed-reducing gears.

The plans were prepared by Hedrick & Cochrane, consulting engineers, Kansas City, Mo., and the field work was supervised under their direction, with C. S. Reagan as resident engineer. The bridge was erected by the Missouri Valley Bridge & Iron Company of Leavenworth, Kan. The steel was furnished by the American Bridge Company. The consulting engineers attribute much of the success of this construction to the many valuable suggestions made by the engineering departments of the Missouri Valley Bridge & Iron Company and the American Bridge Company.

Literature

For the Civil Engineer and Contractor

New Publications

General Specifications for Concrete Work as Applied to Building Construction. By Wilbur J. Watson. Second edition, revised. Paper; 8¼ x 10¾ in.; 56 pages, illustrated. New York, McGraw-Hill Book Company, Inc. $1 net.

Proceedings of the American Society for Testing Materials, Vol. 15, 1915. Part 1, Committee Reports; Part 2, Technical Papers. Cloth, 6 x 9 in.; 485 and 477 pages respectively. Philadelphia, published by the society, Edgar Marburg, secretary-treasurer, University of Pennsylvania.

Gravity and Pressure Tanks, Concrete Reservoirs and Valve Pits. Regulations of the National Board of Fire Underwriters Recommended by the National Fire Protection Association. Paper; 3½ x 5¼ in.; 88 pages, illustrated. Boston National Fire Protection Association.

Annual Statistical Report of the American Iron and Steel Institute for 1914. Cloth; 6 x 9 in.; 118 pages. Philadelphia, Bureau of Statistics of the Institute, 261 South Fourth Street.

Production of iron ore, coal, coke, iron and steel products, imports, exports and average monthly and yearly prices, with numerous tables.

Pit River Project in California. By E. G. Hopson supervising engineer, U. S. Reclamation Service. Paper; 5⅞ x 9 in.; 55 pages, illustrated by photos and drawings. Washington, Government Printing Office.

An official report on the Lower Pit River project discussing the irrigation of about 55,000 acres of land in the Sacramento Valley in and in the vicinity of Shasta County, California.

Pit River Basin in California. Prepared by E. G. Hopson, supervising engineer U. S. Reclamation Service under an agreement for co-operative work by the United States Department of the Interior and the State of California. Paper; 5¾ x 9 in., 140 pages, containing colored insert plates as well as an unusually large number of maps and other illustrations. California, State Printing Office.

An official report dealing with investigations made in 1914 and 1915 under the co-operative plan, through engineers of the Reclamation Service and the Engineering Department of the State of California, reviewing the topographic divisions, geology, forest cover and precipitation within the basin and discussing the need of water transportation and irrigation of 177,600 acres of land in northeastern California, lying in Modoc, Lassen, Siskiyou and Shasta Counties.

Books Reviewed

Rivington's Notes on Building Construction

Edited by W. Noble Twelvetrees. Cloth, 5½ x 8½ in.; Part I: 306 pages, 484 illustrations. Part II: 332 pages, 395 illustrations. New York, Longmans, Green & Co. $2.25 net each.

Reviewed by F. H. Constant

Professor of Civil Engineering, Princeton University, Princeton, N. J.

This is an English work in two volumes, of about 300 pages each, intended as a practical guide and compendium for architects and builders. The first edition was published forty years ago, primarily to assist students in their preparation for examinations in building construction under the Board of Education, South Kensington. But the book has had a wider field as a reference work for architects and builders. The first revision was made ten years ago and the present edition (both volumes), has been entirely rewritten to bring it up to date. A unique feature of the work is the different authorship of the various chapters, mostly by architects of high standing. A list of the contributors appears on the front page of each volume.

The work is wholly descriptive and entirely free from mathematical treatment or formulas. The object of the books it to furnish practical information upon the multitudinous details in the building art. In this respect it is characteristically English, placing emphasis upon established custom and practical rules rather than upon mathematical principles and formulas. Since methods and details of practice are different in many respects in the two countries, it is not likely to find a very wide use in this country. Carrying out the original purpose of the book, each volume is concluded with a list of selected examination questions set by various institutes, guilds and colleges.

Surveying and Field Work

Author, James Williamson, A.M., Inst. C. E. Cloth, 8½ x 6 in.; 363 pages; 271 illustrations. New York, D. Van Nostrand Company. $3 net.

Reviewed by A. F. Comstock

Associate in Railway Engineering, University of Illinois, Urbana

To produce a sound textbook on the principles and practice of surveying has been the author's purpose in preparing this work. Though intended mainly for use in technical schools and colleges, the book is meant also as a reference work for practitioners. It is published as one of the British series of Glasgow Textbooks on Civil Engineering.

In arrangement, the time-honored custom of beginning with chain surveying is adhered to. Then the compass, sextant, theodolite and level are treated in the order named, with an accompanying array of applications of the several instruments to typical problems in surveying. Only the work embraced in elementary surveying is attempted, and therefore such subjects as meridian determination, geodetic surveying and plane-table surveying have been excluded. Considerable attention is given to the errors of surveying, and to plotting and computing. A chapter on setting out curves, one on earthwork calculations, and one on sections and contours (topographic surveying) compose the latter part of the book.

There is little individuality to the work, which is due, no doubt, to the large number of books on the same subject in this country. For American needs the book appears to the reviewer to be concerned too much with details to make a desirable text, and to lack the scope usual in the more commonly used reference books. The descriptions of methods, however, are unusually explicit.

Mechanical Drawing for Colleges and Universities

Authors, James D. Phillips and Herbert D. Orth. Cloth, 6 x 9 in.; 283 pages. Chicago, Scott, Foresman & Co. $1.75,

This book is designed to meet the needs of the vocational student and assumes no previous familiarity with the subject. The text therefore presents the various topics in a very elementary way, taking up the different phases of instrumental drawing in a carefully graded sequence so that a beginner may absorb his instruction with the least effort. The book begins with two chapters on sketching, follows this with chapters on mechanical projection drawings, use and care of instruments, conventions, lettering, isometric and cabinet projection drawings, and closes with suggestions for the instructor.

The elementary character of the treatment adapts the book for beginners in a technical high school or in a college where the subject is taught for its cultural value only. For the engineering college, if a text is to be used at all, something more vigorous is needed.

Elements of Railroad Track and Construction

Second Edition. Author, Winter L. Wilson, professor of railroad engineering, Lehigh University. Cloth, 5 x 7½ in.; 396 pages; 210 figures; 32 tables. New York, John Wiley & Sons, Inc., and London, Chapman & Hall, Ltd. $2.50 net.

The first edition of this work appeared in 1908, and was put forth purely as a textbook, in the belief that more elaborate volumes were not suitable for classroom work. The new edition contains numerous revisions to conform to recent developments in the art, and there have also been two new chapters added on "Practical Turnouts" and "Grades." In all 76 pages have been added. It is unfortunate that the overhauling process missed some obsolete matter entirely, and that some of the revisions are now themselves out of date. One sees references to the 1911 "Manual" of the American Railway Engineering Association, but none to the later supplements. Consequently there is no mention, in the discussion of ballast cleaning, of the screens used so successfully by the Baltimore & Ohio for the last two or three years. As to the book itself, while it certainly goes farther than some other railroad textbooks in informing students that a railroad, to be successful as such, must be something more than a single track from A to B, it still fails to give them a very clear idea of how the railroad works.

The author has wisely discussed the elements of the track itself before telling how to build it. After a short historical chapter, he proceeds with permanent way. This chapter has been considerably revised and rearranged, and gives the student a good knowledge of ordinary track. As previously suggested, the revision falls short of being up to date by about four years, which is a long time for tieplates, screw spikes, ballast cleaning and rail specifications.

To the former chapter on circular turnouts a new one on "practical turnouts" has been added. They could perhaps better be labeled "semi-practical" as the author treats them. He makes the use of the practical turnout a mere expediency, and fails to show that the abolishment of the stub switch and the introduction of the switch-point angle made the circular turnout an impossibility. The chapter on circular turnouts could well have been discarded entirely. Instead the student is led in the new chapter through various mathematical gymnastics for calculating turnouts that he will probably never use after graduation, but is not informed that these things are standardized for each road, that it will be important for him to learn the switch leads, which are totally different from those given in the author's table, and that certain numbers of turnouts are desirable for certain operating conditions. The author's illustrations and problems are confined to Nos. 6 and 8, which certainly do not clearly suggest best modern practice.

The author's treatment of yards is badly jumbled. He confuses trackage for local business with that for operating the road; first he makes it appear that a yard is essentially an enlarged siding for loading and unloading cars, and then, after indirectly recognizing the terminal switching yard, he implies that along with the passenger and freight station, it should be in the heart of the city. It is too bad that the author could not have given the space filled with mathematics in the chapters on turnouts to an adequate presentation of the vital question of yards and terminals.

In this same chapter is a brief outline of signaling, without, however, any mention of upper-quadrant signals.

The foregoing chapters constitute half of the book. The remaining chapters, though less revised, are better. There is a good chapter on maintenance organization and tools, faulty mainly in ignoring the growing use of machinery for maintenance. Copious space is given to signs. The chapter on the engineer corps for railroad construction has been enlarged and is a useful one for the student. The three succeeding chapters, on the subgrade, trestles and culverts, are substantially as they appeared in the first edition, and are well presented. The importance of the drainage of roadbed could have been emphasized more fully. The book closes with a short new chapter on grades, useful mainly for its information for computing vertical curves.

The reviewer realizes that it is no easy task, in preparing a new edition of a book, to bring it thoroughly up to date without rewriting it completely, and assumes that in this case the revising has occupied several years. It seems important, however, that the student of railroad engineering should be apprised of the latest developments in the field, especially at the date of issue of the book. The author has accomplished his purpose in producing a usable textbook, eliminating the mass of detail the student has neither the time nor the experience to comprehend, and undoubtedly the young graduate who enters the railroad field with a mastery of this book will have a much better understanding of railroads than the average. The way is still clear, nevertheless, for a text that will give correct relative values to the different railroad units and show how they fit into the railroad machine, avoiding the textbook habit of parading facts without explaining their comparative weights.

Letters to the Editor

Comment on matters of interest to engineers and contractors will be welcomed

Decimals of the Full Circle

SIR: I read with interest R. C. Hardman's letter relative to the introduction of the decimal division of the degree in place of the sexagesimal by Prof. William G. Raymond in his new railroad field engineer's manual. Mr. Hardman is evidently under the impression that the decimal subdivision of an ordinary degree is something new, whereas it is the original subdivision used by Briggs as far back as 1633, followed by Roe and Oughtred (all in England). Thomas Graham Gribble designed and had built some time about 1888 what he called his "ideal tacheometer," in which the plate was decimally divided as to degrees. In Gribble's "Preliminary Survey and Estimates" he says:

"By this means (the decimal division of the degree) all the advantages of the centesimal graduation are obtained while retaining correspondence with the published astronomical ephemeris."

"Tables to five places of decimals for the trigonometrical functions, together with logarithms of numbers of five places, can be procured. . . . They are compiled by Dr. C. Bremiker. . . . They are the only tables extant for this graduation. Transits can be adapted by merely changing the vernier."

It may be well to mention that Gribble wrote the above in 1890, since when other tables may have been published. There have doubtless been many attempts, since Roe and Oughtred's, to get rid of the senseless sexagesimal subdivision, which survives in spite of them.

Thus are we hidebound by traditions.

F. H. FRANKLAND,
Bridge Engineer, Highway Department,
Calcasieu Parish, Louisiana.
Lake Charles, La.

"The Changed Reclamation Service" Again

SIR:—Your editorial of above caption in the issue of July 31 attempts to sum up the Reclamation Service situation by saying that disgruntled water users failed to make good their case at Secretary Lane's Washington conferences; that the inauguration of commission control and the opening of the Denver office are presumptively mistakes or at least questionable; that too much has been granted disgruntled elements of the West, and, finally, that the lengthening of the time of payments for water rights (construction charges) was a concession to elements that are never likely to make a success of irrigation farming.

It is believed that your position and conclusions have failed to take into account some fundamental facts that would alter your viewpoint. The writer hopes to point out how Secretary Lane is working out, evidently, a policy that will solve the riddle of irrigation farming success now baffling the West to its greatest detriment, and how the fruition of his policy in the service would point the path for private enterprise which capital now fears to tread, and, in conclusion, how this would again open the field of irrigation construction to innumerable engineers who have had to forsake the field for lack of work. If my analysis is right, the Engineering Record, as one of the foremost authorities in its line, should see in Secretary Lane one of the best friends of the civil engineer, and it should give him its heartiest support in his most difficult task.

To begin with it is beyond argument that the Reclamation Service was organized to bring water to the land to reclaim the desert for homes for worthy Americans, presumably with little or no money or capital, who were willing to work, and who were to *return* the cost. Most unfortunately the old service was immediately most thoroughly imbued with the idea that "reclaiming the land" consisted merely in building reservoirs and leading the water to the land in a ditch; and even at this very moment that definition of "reclaiming the land" is paramount. Though the settlers are to return the full cost of a project as incurred by the engineers, as evidenced by a decision of the Supreme Court of the United States, nevertheless the engineers paid scant attention to the water users and their early successes, though it is most palpably evident that every dollar of the engineers' expenses must eventually come from the ground itself—thus making it imperative that the agriculturist make good. Reports by the thousands fill the service files, but I know of not one upon the achievements of the settler.

Almost immediately there was disappointment among the settlers. The facts were that they were not making good principally because they attempted with $1,000, $500, or almost nothing, to reclaim an irrigated farm. It is confidently asserted that that operation requires $5,000 of outright capital investment and the Engineering Record itself has, in articles from that eminent, able and best posted engineer, Dr. Elwood Mead, published statements that it costs $6,000. In his difficulty the settler naturally turned to the service for help, asking easier terms of payments by a graduated scale that was entirely permissible under the Reclamation Act, but the service was blinder than the settler in seeing what an impossible task had been undertaken. It turned a deaf ear to appeals for aid—even boldly asserted that the settler was shamming and would come across if the cut-throat water contract of the Government was enforced. Furthermore, the service even stated in the advance copy of the Eleventh Annual Report and in the *Country Gentleman* that 80 per cent of the settlers were lazy and shiftless in that it said: "The physical elements of success are now present, and if the majority of the settlers will use the same energy and skill that are practised by 20 per cent of them, general and great prosperity will prevail on all of the irrigation systems. The incompetent and lazy must be weeded out." Only a month or so before Secretary Lane's advent, inspired articles said that reclamation would be an immediate success if only Congress had the heart (or heartlessness) to enforce the law, which was then, remember, the same cut-throat contract that would automatically confiscate one's holdings by cancellation on failure to meet a payment, such as is so common to land companies anxious to make inordinate profits by that method.

Secretary Lane's Washington conferences resulted. It was quite unfortunate that your representative there was not able to read between the lines. Secretary Lane was able to do so. The settlers' representatives did not make good, it is true, for they were partly self-assertive, self-appointed delegates who, though they asked for twenty-year payments, were more concerned in urging that their organizations might take over administration of the projects, with themselves, of course, at the head of the new forces. Secretary Lane saw what the service had failed to see in ten years till his advent, and what your representative failed to read, that is, that the settler was "up against it," and he took the first progressive step towards common-sense reclamation in obtaining the twenty-year payment law. It cannot possibly take the place of capital in preparing the land to produce crops, but it saved a harvest of confiscation in the West and came as a sign of a sane policy at last. It is merely one step of many already trod by foreign governments long engaged in this work. They have learned more than we have dreamed of. Dr. Elwood Mead's analysis of "Rural Credits" at the recent Irrigation Congress will quite clearly elucidate this to the doubting.

The appreciation of conditions as disclosed by the Washington hearings undoubtedly led Secretary Lane to call his conference of Western Governors, for he stated in the call that reclamation projects were "sick" and their condition called for action. You should know well that he was met half way by politicians eager to fight over Federal control of our natural resources. Our governors never even caught the "scent," and an irrigation policy was as far off as ever.

It should be evident to those who will do a little thinking that Secretary Lane has got no help from the service, from the water users, from the engineering profession, nor from the West. The Irrigation Congress just held in California offers to him the first constructive thought in a large way. His early work necessarily must have been based on his personal investigations. We should appreciate the wisdom of his actions.

Barring some early mistakes necessarily to be expected, the Reclamation Service has a record in engineering that on the whole it may be proud of; the diverse tasks thrust upon it presented more of a problem than the Panama Canal, with its relatively single task of removing a body of earth; the service surmounted its tasks without a question of graft ever coming up. The success of the service, however, hinged on social, economic, legal and agricultural factors that were somewhat overlooked. The just inference was that such a complexity of problems should not be thrust on or trusted to the wisdom of one man, and hence the Reclamation Commission was organized in order that wider experience in these various factors should determine action. The excessive "overhead charges" in Reclamation Service work were most justly subject to attack by the water users who eventually must pay them. Efficient organization of operation and maintenance forces was making for lower costs quite rapidly, but this was not so evident in construction work. The volume of work could not justify the scattered forces in 1914, with principal construction already accomplished. The Denver centralization is certainly justified as making for economy; the efficiency of the office is up to itself. All friends of Western reclamation must hope that the rights and needs of the water users who pay the bills will from now on receive due consideration, that the diverse factors of the work will receive as much thought as the engineering, and that the invaluable experience of years of actual work on the part of the service's trained engineers will unhesitatingly be taken advantage of.

There is ample evidence that Secretary Lane knows that the twenty-year payment law is not adequate to insure the success of the settler, and thereby that of the service. The "sine qua non" of his success is the *engineering* preparation of the surface of the land to suitable grade and shape for successful irrigation with a minimum of 2 or 3-in. applications of water. The resulting duty would be 3 and even 2 acre-ft. per acre, and, above all, no water would be added to the ground water, thereby eliminating 60 per cent or more of the cause of the dreaded, devastating seepage. All of this would mean an eventual crop average of 100 per cent or more in excess of the ridiculous and absurd $20 and $25 per acre average returns now obtaining.

The achievements of the settler are now of paramount importance. If Secretary Lane shows how to give him a chance, it means not merely the rejuvenation of Reclamation Service activities but a revolution in our methods of colonizing and settling projects. The business man, banker, county and State will all then know that the adequately financed settler is the one that spells success for them, and they will take such steps to finance him or provide him with stock as may be necessary.

Considering the sources of information that are open to us it is simply amazing that our leaders in engineering are not aware that the difficulties that have resulted in the quite general abandonment of one of our most important fields of engineering construction work have been investigated, understood and met by other countries some years back. It is hoped that this communication has helped to make clear that we stand in dire need of a demonstration of how to meet the needs of settlers to insure their success; that there is no chance of this through private projects at present, nor through the efforts of any of the States, inasmuch as their efforts would be sure to be more or less negatived on account of a lack of continuity of a policy due to changing administrations; that the Federal Government has adequate means and sufficient continuity of policy to carry to success such a demonstration; that Secretary Lane is doing his utmost to proceed wisely; that success on the part of his water users means an immediate impulse and expansion in irrigation construction work and the expenditure ultimately of millions on the part of the Government and private interests; that the partly abandoned irrigation field is one of the largest for the engineer; that the engineer is not using a grain of his gray matter in helping toward the solution of the problem which rests on Secretary Lane's shoulders.

Only the settler can bring prosperity to the West. Grubstake him properly and, instead of operation engineers now being the only ones left in the work, as indicated by the Engineering Record's editorial of Aug. 21, in its comments on the report of the State Engineer of Colorado, the locating and construction engineer will again be busy. This view is urged on the profession as no idle dream but as absolute fact based on years of study of the decline of irrigation activity.

AMICUS CURIAE.

Public Speaking

SIR: An editorial in the Engineering Record of Oct. 23, page 497, referred to the importance to engineers of acquiring the ability to speak well in public, and suggested that associations of engineers might consider, for the benefit of their membership, the organization of courses of instruction in public speaking, designed especially for engineers.

I heartily concur in your views regarding the importance of this subject to engineers. Facility in expressing one's thoughts clearly, whether to an individual or simultaneously to a group of individuals, is of the greatest importance and value to everyone, without regard to his trade, business or profession. It is, however, admitted by engineers that in general the members of their profession are more deficient in the power of expression than the members of other professions.

The engineering societies afford an opportunity for their members to develop in this respect, by taking part in the presentation and discussion of technical and other subjects and, in fact, I feel confident that a large proportion of the older members of these organizations would, if called upon, testify that opportunity for improvement in public speaking is one of the greatest advantages of membership in such organizations.

However, a much more direct way to become an effective public speaker is to join a class with others similarly interested, under the guidance of a thoroughly competent instructor. Fortunately for engineers and others in New York and vicinity, the opportunity is available at small cost, and I feel sure that you will be doing a real service if you will call attention in the Engineering Record to the excellent course in public speaking given at the West Side Young Men's Christian Association, Fifty-seventh Street, New York, by a thoroughly competent, practical and conscientious instructor, Walter Robinson.

Many business and professional men of this city have profited by instruction in this course in previous years, and highly recommend it. The classes are composed of men of various ages and vocations; lawyers, physicians, engineers, architects and other professions being well represented. This diversification of interests is a decided advantage and the resulting benefits are far superior to those which could be attained in a class composed entirely of engineers.

F. L. HUTCHINSON.
[Secretary, American Institute of Electrical Engineers.]
New York City.

MUNICIPAL HARBOR OPERATIONS AT LOS ANGELES during the past few months are said to hav resulted in the accumulation of a surplus of $40,000 over and above operating and maintenance expenses and investment in permanent equipment.

HINTS FOR THE CONTRACTOR

Details Which Save Time and Labor on Construction Work

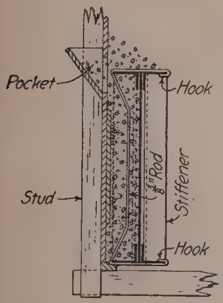
Other articles in this issue of interest to contractors and construction engineers are indexed in the Table of Contents

[*Contributions to this section are solicited, and if found available will be paid for. They must be* SHORT, *and should be accompanied, if possible, by photographs or sketches.*—EDITOR.]

Reinforcing Spring in Place Holds Concrete to Plate Girders

By R. C. HARDMAN
Colorado Springs, Colo.

ON A PIECE of construction work recently completed a number of plate girders 62 and 67 ft. long required a covering of concrete on one side only to secure uniformity with adjoining concrete girders. The simplest method, of course, would have been to punch the web at intervals and insert suitable anchors. As this had not been done, however, and as the work of drilling holes would have been costly because of lack of the proper equipment, the method shown in the accompanying drawing was adopted. As will be seen, ⅜-in. round rods were bent to the desired shape and put on the girders. The ends were then bent around the flanges to form hooks, and each rod drawn perfectly tight by springing it in toward the center of the web. The hook around the top flange was covered by the concrete, while that at the bottom was necessarily left exposed.



The girders were made up of a web 3 ft. 6 in. deep with 4 x 6-in. angles forming the top and bottom flanges and stiffeners. The thickness or concrete required was 7 in., which left but 1 in. space between the form and the flanges and stiffening angles. The space left for placing concrete was thus too small for rapid work, even if a special aggregate were used. Therefore, a form was designed in which small holes, or pockets, were cut at about the center of each panel between stiffeners. In the later forms this was modified by making a larger pocket at each alternate stiffener so that two panels could be poured from one opening. The pockets, which were about 8 x 12 in. in the first form and 8 x 20 in. in the others, were provided with a projecting lip on the outside, which formed a sort of funnel, the opening at its top being slightly above the top of the flange. In pouring the deck of the span the girder form was filled simultaneously by two men, who shoveled concrete off the deck forms into the funnels. To avoid loosely placed concrete it was spaded through the pockets and between the flange and form with a specially constructed tool made of a flat 4 x 6-in. plate welded to the end of a ½-in. hexagonal rod. This spading was done very thoroughly, resulting in a very uniform face. As the material was placed very slowly, it was spaded a great deal more than is usually the case in concrete work.

Ditch Dug with Dynamite at 15 Cents per Cubic Yard

A DITCH 400 ft. long and 12 ft. wide was recently dug with dynamite at Carney's Point, N. J., in one day at a cost of 15 cents per cubic yard. The ditch was across a mud flat from a sluice gate to the Delaware River. The ground was soft, water-filled mud covered with a dense growth of reeds. These were first cleared off for a width of 15 ft. along the line of the ditch. As the ditch was to be only 4 ft. deep, the holes were made by pushing a long shovel handle down full length. Three rows 4 ft. apart were made, with the holes 18 in. apart and 3 to 4 ft. deep. Each hole was loaded with two cartridges of 60 per cent dynamite, one at the bottom and one about 18 in. from the top. Some of the holes in the middle row were loaded with three cartridges, two at the bottom and one 12 or 15 in. from the top. Electric blasting caps were placed every 50 ft., and fired with a No. 5 blasting machine. The result was a perfect ditch, which filled with water at high tide, 3 hours later. The dynamite cost $120 for the 800 lb. used, the exploders 50 cents, and the four men who did the work were paid $8, making a total cost of $128.50. The ditch was constructed under the direction of A. E. Anderson, and was described in the *DuPont Magazine* for November.

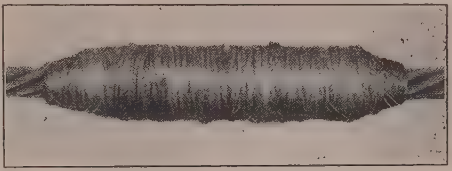
Dragline Bucket Picks Up Big Rock

THE accompanying photograph, taken recently, shows a rock containing 136½ cu. ft. of material being handled by a 3½-cu. yd. dragline bucket owned and used by Shnable & Quinn, the contractors for the section of the Calumet Sag Canal on which the photograph was made. The bucket, one of those designed by Mr. Schnable for this work, was under a good strain, as it gripped its unwieldy load only by one end. The big stone was, however, landed in safety. It measured 12 ft. long and 21 in. thick, with an average width of 6 ft. 6 in., and its weight is estimated at 10 1/6 tons.

HANDLING A BIG ROCK

Oil Drillers Develop Good Wire Rope Practice—Do Not Jerk Loads

"POSSUMS" like the one shown herewith are widely used by oil men to save wear on their drilling ropes by preventing friction against the sides of the well casing. When made of tarred marline wound in the form shown, they will last a long time, and can pass over the large-diameter sheaves used on well drills and wind up on an ordinary-sized drum without trouble. They are especially effective in a hole where the casing has gone out of plumb, and without them the casing may easily be cut through by the cable.



CORRECTLY-MADE "POSSUM"

Other instances of the wire-rope practice of oil drillers which should be as useful to drillers and riggers on construction work have been collected recently by A. Leschen & Sons Rope Company. One of these is to run a new drilling line for a few times after it is put on without doing actual work. This allows the line to get its "set." All kinks should be taken out by hammering them with a wooden or copper mallet on a wooden block. Unless this is done, the strands on the outside of the kink will soon wear through.

Experiments made by putting a dynamometer between the cable and its load have shown this company that a load raised suddenly with only 2½ in. of slack in the cable puts a strain on the rope 39 per cent greater than the weight of the load, while with 12 in. of slack the rope stress was triple that caused by picking up the same weight slowly with a taut cable. The obvious conclusion that, where a line is slack, the load should not be raised with a jerk, unless the chief aim of the operator is to increase the consumption of wire rope, applies not only to drilling, but also to driving piles with a drop hammer and to many other kinds of construction work.

Green Brush Used Instead of Close Sheeting in Sand Trench

FRESHLY-CUT brush with the leaves still green was used with success as a substitute for close sheeting in a water-main trench about 4 ft. wide and 6 ft. deep through pure sand on a contract recently completed. Had the necessary lumber been available, the foreman would doubtless have sheeted the entire trench, but, confronted as he was with a material that could be rapidly shoveled out and a pipe laying gang stepping close on his heels, he could not wait for lumber. He placed his rangers and cross-braces in the same way as is done in ordinary skeleton bracing, but instead of putting breasting planks 6 ft. or so apart, he spaced them about a foot apart and packed in behind and between them the fresh brush cut down in making a road for the teams and clearing the pipe line right-of-way. The experiment proved so successful that the scheme was used in similar trenches throughout the job, with considerable saving of lumber and without any noticeable increase in the cost of labor.

Derrick-Trolley Carries Dirt Beyond Caving Banks

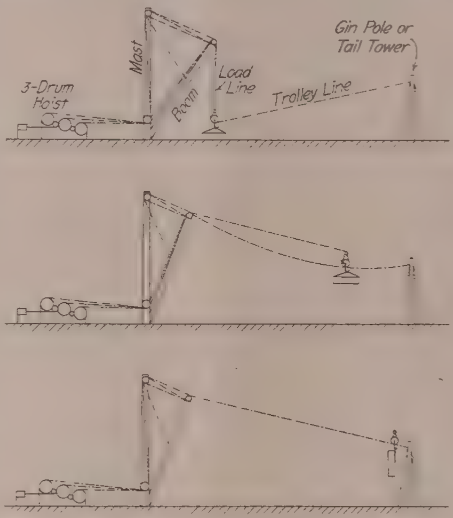
THE TROLLEY rigging illustrated in the accompanying drawing was used at the Sabine-Neches guard lock in Texas to deposit excavated material at a distance from the lock site. This was made necessary by caving banks. The rigging was described by M. A. Milliff, superintendent at the lock, on page 761 of *Profession Memoirs* for November-December, 1915.

The bulk of the excavation for the head bay and tail bay lock pits had been made with a hydraulic dredge previous to building the cofferdam. It was the intention to use wheelbarrows to complete the excavation, but after the lock had been unwatered for a short time the banks began to cave and slide in, and it was found that excavation could not be done economically in this way. A derrick was then set up, depositing the excavated material as far as the boom would reach. The dumping area thus provided, however, proved insufficient, as the weight of the material deposited caused further sliding and crawling of the banks. As the amount of material to be moved did not justify installing a cableway or additional derricks, it was necessary to arrange some way of moving the dirt the extra distance required with the plant at hand.

The three-drum hoisting engine used had the load line wound on the back drum. The trolley line was carried on the middle drum. The load line, which was single, was fastened to the top of a single steel block from which was hung the skip. Through this single block, which served as the trolley block, was rove the trolley line. The end of the trolley line was carried out and made fast to the top of a gin pole set up and guyed far enough from the derrick to permit dumping the excavated material well back of the caving banks. The boom line was wound on the front drum. The boom line was usually dogged, and in one rig was led to a hand crab, using a two-drum hoist to handle the other lines. The boom was always kept in a high position to make the trolleying possible, and its angle was seldom changed. The single block used was of the ordinary type with swivel hook, and with four bolts, one in each corner of the diamond-shaped cheek plates. The bolt on the side of the block which hung next to the mast had, of course, to be removed, as it would have interfered with the trolley cable in operation.

The material box used was an open-end skip of 1 yd. capacity fitted with three chains, one to each back corner and one to the middle of the front side. The front chain was fitted with a trip-hook. Yellow-pine piles 26 ft. long were used for gin poles and were set up on something solid to prevent their sinking into the ground under load.

In operation, the hoisting engineer picked up on the load line, bringing the trolley line tight as the load was raised and swinging the derrick around so that the boom would face the gin pole. When the load was hoisted to the desired height, the trolley line was tightened and the operator held it tight with the foot brake while releasing the load line friction. This allowed the box to trolley toward the gin pole. When the box reached the desired dumping place, the foot brake holding the trolley line was released, allowing the box to drop to the ground. The hook on the front chain was then tripped and the box dumped by bringing the trolley line taut. The box was then returned to position for loading by pulling in the load line, slacking off on the trolley line and swinging the derrick back over the excavation.



TROLLEY IS RIGGED SIMPLY

Two 10-ton steel guy derricks with 90 ft. masts and 75 ft. booms were used on the work. The trolley arrangement has been operated for a distance of 300 ft. with a 12-ft. drop. The load necessary to overhaul the loadline on this flat slope would vary with the condition of the hoist, but it is believed that 2500 lb. at least is necessary. Loading the skip with shovels, one foreman, one hoisting engineer and eight laborers have handled 70 boxes in 8 hr. with this rig. When bailing slush out of one hole, 137 trips were made in an 8-hr. day, with only six laborers employed.

Pipe Line Calker Escapes Injury When Banks Cave In

THE CONTRACTOR who lays large-sized water mains can keep down his liability losses by educating his calkers to emulate a certain "wop" who several times saved himself from caving banks by diving under the pipe he was calking. Many calkers have suffered injury due to the banks caving in while they were in the bottom of deep trenches calking the lower quarter of the joint. A man is often stationed on top to shout a warning if the banks should begin to give. Generally the calker tries to clamber erect and get up to the surface. When the earth moves slowly he often succeeds, but when it comes down with a rush, he is caught. If the calker will slide under the bulge of the pipe in such an emergency, he can generally escape without injury. Those contractors who have tried to backfill their trenches thoroughly know how hard it is to fill the space under large pipes. A falling mass of earth almost invariably leaves a good-sized void in this space, even if both banks cave in. The pipe itself will also serve to ward off any falling rocks of sufficient size to hurt a man taking refuge under it. Even if the calker is completely buried, the void along the bottom of the pipe will enable him to get enough air to breathe to keep him from suffocating until he can be dug out. All he has to do is to lie on his back, keep the tip of his nose up against the iron and retain his coolness, and he may be buried a good many times under large pipes and not suffer in the least.

Cement-Coated Piles Repaired Under Water

WOODEN PILES, wrapped with wire-mesh reinforcing and coated with concrete by means of a cement gun were used by the P. J. Carlin Construction Company in building the San Juan bulkhead in Porto Rico, and described by Mr. Carlin recently in the *Cornell Civil Engineer*. In applying the coating the piles were carried on roller supports 40 ft. apart. As the concrete applied to each pile was 2½ in. thick, the additional weight of the coating averaged 5000 to 6000 lb., which caused some of the piles to sag in turning and handling, producing cracks in the coating.

It may be of interest to explain the method of repairing the damaged cement coated piles under water. This was done by putting on a steel cylinder, about 6 in. larger in diameter than the coated pile, and around the part of the pile to be repaired. All joints were closed and the bottom of the cylinder was made to fit close to the surface of the pile, with the top of the cylinder open. On the deck, above the pile to be repaired, a tank was set up, with a large valve connected to a piece of 1½-in. single ply cotton hose, leading down to the bottom of the space between the pile and the cylinder. Cement grout was mixed in the tank and allowed to run down the hose, a diver keeping the lower end of the hose below the surface of the deposited cement until the top of the cylinder was reached. The cylinder was allowed to remain on for two or three days, then it was taken off and transferred to another pile to be repaired. The results were considered very satisfactory.

It is believed that if some method of rotating the pile, without sagging, during the application of the "gunite" can be devised, and also of handling the pile from the rollers to the seasoning yard, that this method can be satisfactorily, and, of course, economically, employed. It is undoubtedly less expensive than the solid concrete pile.

Mr. Carlin believes that a coating of about 1¼ in. would be very much better than 2½ in. because it reduces the weight on the wooden-pile, and it sufficiently covers the reinforcement.

THE 1914 PRODUCTION OF GYPSUM in the United States, according to the U. S. Geological Survey, was less in tonnage but greater in value than that of 1913. The quantity of crude gypsum mined in 1914 was 2,476,465 short tons, as compared with 2,599,508 tons in 1913. The value of all gypsum marketed was $6,895,989 in 1914 and $6,774,822 in 1913.

NEWS OF THE WEEK

Passing Events in the Civil Engineering and Contracting Fields

Stone Heads $50,000,000 World Trade Corporation

New Company Is Empowered to Engage in Engineering Enterprises of Every Character

Charles A. Stone, Stone & Webster, Boston, has been made president of a $50,000,000 corporation, organized to enter world trade on the broadest lines. Not only will it act as a promoter of foreign trade and deal in the securities of foreign corporations, but also engage actively in the development of engineering enterprises—railways, irrigation and hydroelectric projects, water and sewerage systems, etc.

The new enterprise, known as the American International Corporation, has a very strong board of directors, including Edwin S. Webster, of Stone & Webster; W. L. Saunders, president of the Ingersoll-Rand Company; Guy E. Tripp, chairman of the board, Westinghouse Electric & Manufacturing Company; Charles A. Coffin, chairman of the board, General Electric Company; Joseph P. Grace, W. R. Grace & Company; Frank A. Vanderlip, Theodore N. Vail and James J. Hill.

Erie City Council Adopts Flood Prevention Plans

The City Council of Erie, Pa., has adopted the plan recommended by the firm of Farley Gannett, consulting engineer of Harrisburg, Pa., for the prevention of flood damage in that city. The carrying out of this plan, which was described in detail on page 440 of the Oct. 9 issue of this journal, will involve an expenditure of about $900,000 for construction to consist principally of about 12,500 ft. of reinforced-concrete conduit, 22 ft. wide by 18 ft. high., to handle Mill Creek. A resolution has been introduced in the City Council for the appropriation of funds for the first year's work. The money will be raised by the sale of bonds, which may be issued by the council without a vote of the people.

State Can Stop Pollution of River

Terminating, so far as the State courts are concerned, a litigation which has been in progress for nine years, the New Jersey Court of Errors and Appeals has sustained the right of the State of New Jersey to prohibit the pollution of the Delaware River, notwithstanding the lack of concurrent action on the part of Pennsylvania.

The immediate effect of the decision is to uphold a decree of Chancellor Walker directing the city of Phillipsburg, N. J., to cease sewering into the river or otherwise polluting the stream through the maintenance of garbage dumps along the banks.

The more far-reaching effect of the decision is to uphold the powers of the State Board of Health to continue its crusade to purify the river by enforcing similar orders against other municipalities along the Jersey shore.

Twenty-Six Cement Companies to Participate in Cement Show

Twenty-six cement companies, shipping cement within 1000 miles of Chicago, will participate in the cement show to be held at Chicago, Feb. 12-19, 1916, at the First Infantry Armory and the Coliseum. The materials for the exhibit will be drawn from the resources of practically the whole cement industry. All duplications of cement companies will be eliminated by a joint exhibit plan, which will enable the manufacturers to install such a display as has never before been attempted.

The Second National Conference on Concrete Road Building will be held at the Auditorium Hotel, Feb. 15-18, in connection with the Cement Show, and it is the intention to have on display at the show such specimens of concrete road work as will be discussed at the conference.

Cleveland Engineers to Print Descriptions of Engineering Works

As a result of a meeting of the Cleveland Engineering Society, Nov. 9, at which the "Future of the Engineering Profession" was discussed, the society has adopted a plan to issue a special number of its journal, containing popular descriptions and illustrations of recent progress in engineering works. The discussion followed upon papers on the future of the profession by E. H. Whitlock and A. J. Himes, the former chairman of the local sections committee of the American Society of Mechanical Engineers, and the latter valuation engineer of the New York, Chicago & St. Louis Railroad and member of the National Committee on Engineering Co-operation.

Engineers Predominate in City Manager Association

On Publicity of Accomplishments and Retention of Public Interest Depend Success of the Manager Movement

Twelve of the seventeen city managers meeting in Dayton, Nov. 15, 16 and 17, at the second annual convention of the City Managers' Association, were engineers. About seventy cities have voted to be run by a manager, but in about twenty the date of appointment has not yet arrived.

Proper and effective methods of getting publicity of results accomplished and what the new movement means to the citizen cropped up in the discussions at all meetings, in addition to a special paper on the subject of Winton Miller, city manager, St. Augustine, Fla., formerly executive secretary in the Dayton manager's office and previous to that a newspaper reporter.

CITY MANAGERS WHO HELD ANNUAL CONVENTION AT DAYTON, OHIO, LAST WEEK *Photo. S. R. Kremer, Dayton*

1, H. G. Otis, Beaufort, S. C.; 2, H. M. Waite, Dayton, Ohio; 3, G. C. Cummin, Jackson, Mich.; 4, Kenyon Riddle, Abilene, Kan.; 5, H. N. Beck, Grand Haven, Mich.; 6, W. C. Miller, St. Augustine, Fla.; 7, S. C. Cornwall, Hickory, N. C.; 8, O. E. Carr, Cadillac, Mich.; 9, S. C. Barnwell, Rock Hill, S. C.; 10, Karl Mitchell, Sherman, Tex.; 11, W. F. Fairbairn, Big Rapids, Mich.; 12, J. S. Ekey, Grove City, Pa.; 13, T. A. Wilson, Clarinda, Iowa; 14, C. E. Ashburner, Springfield, Ohio; 15, M. H. Hardin, Amarillo, Tex.; 16, C. A. Bingham, Norwood, Mass.; 17, R. L. Fitzgerald, Winnetka, Ill.

H. M. Waite, city manager of Dayton, brought out the point that the more efficient the government, the colder from the human interest standpoint it was likely to become. In consequence a special effort had to be made to present to newspaper men some one thing which would make the reporter's ears tingle until he could get his story on paper.

Gaylord C. Cummin, city manager of Jackson, Mich., found public interest decidedly at a low ebb unless a fight were staged. He proposes to build the new city hall as an office building and to show the windows for municipal exhibits, to be changed at frequent intervals.

Mr. Miller has adopted the same scheme as is used in Dayton, viz., that of leaving all correspondence in an open file for one day for the reporters to read over and get tips. Interviews are then granted if desired.

C. E. Ashburner, city manager of Springfield, Ohio, believes the deeds and acts of the city's employees are the best means of arousing interest, although he takes the reporters into his confidence at all times and through them the people at large.

In making reforms be sure not to go too far beyond the people, said Mr. Waite. In Dayton they have stopped promulgating new ideas because the citizens began to weary of the new things.

A campaign for nine bond issues involving

$1,000,000, largely for engineering structures, was won by a 3 to 1 majority by an intense diffusion of knowledge in more or less spectacular ways of what the money would go for.

Necessity for a co-operating citizenry and how it was being attained was a common thought in the reports of all the managers.

Fowler S. Smith, purchasing agent of Dayton, in his paper on "Purchasing Methods" outlined the Dayton system and expressed the opinion that cities should have purchasing agents with experience and tact more nearly equal to that of the various selling agents with whom they must deal. Otherwise the transaction is a one-sided affair with the odds distinctly against the municipality.

Gaylord C. Cummin gave a detailed account of making up a complete budget for Jackson, Mich. The scheme is practically the same as that used in Dayton and Springfield.

To clear the various ideas and experiences gained in trying out new procedures under the new form of government it was decided to have each manager send information to Mr. Waite each month. This will be multigraphed and passed on to those managers who desire it and will bear their share of the cost.

A committee on standard accounts and forms will gather information from the various cities and at the next convention will arrange them in an exhibit.

The officers elected for the coming year are: H. M. Waite, president; S. C. Barnwell, vice-president, and O. E. Carr, secretary and treasurer. The next place of meeting will be decided by Mr. Waite after a conference with the National Municipal League with the idea of arranging another joint meeting. The latter organization will probably not make its decision until next April.

Water Problems Studied by State Committee in California

The State Water Problems Conference, created by the last California Legislature for the purpose of considering and recommending to the 1917 Legislature a unified State policy with reference to irrigation, reclamation, water storage and flood control, with due regard to the needs of water power, mining and navigation, recently held its first meeting in San Francisco. A number of papers on various phases of the water problems of the State were read and a larger number, sent in by mail, were classified and filed for the use of subcommittees.

Sacramento River Floods

E. G. Hopson, consulting engineer of the United States Reclamation Service, pointed out that reservoirs could not be considered a solution of the flood problem in the Sacramento River basin. "All the reservoir sites in the valley are known to us and have been surveyed," he said. "The only two effective sites are those at Iron Canyon and the Pit River, and these could care for only the peaks of the floods. All the sites available for storing flood waters would produce only an insignificant effect." In the discussion following Mr. Hopson's comment it was agreed that the by-pass system of flood control is the only one feasible for the Sacramento valley.

The unattractiveness of irrigation district bonds was ascribed by C. P. Eels, an attorney of San Francisco, to the confusion in the forty laws governing such bonds, the absence of an adequate limit to the amount of bonds which a district may issue, and the lax assessments in the district under which interest is paid and the redemption fund accumulated.

A State Board of Public Works

C. E. Grunsky, president of the American Engineering Corporation, suggested that a State Board of Public Works be formed to handle all State engineering work and to replace the State Water Commission, the State Conservation Commission, the State Highway Commission, the Reclamation Commission and the State Engineering Department. In other words, such a board would handle road construction, dam inspection, construction of public buildings, and irrigation, reclamation and drainage matters. A constitutional amendment would be best, he thought, to give this board a sound foundation.

There should be a complete State Control of all new irrigation developments, Mr. Grunsky thought, and he pointed out the improvement that would result from giving State backing to irrigation district bonds so as to make them altogether independent of the success or failure of the district. Interest and principal should be cared for by special tax assessments. Sinking funds should not begin until 5 years after completion of the projects, and irrigation districts, he said, should have a relation to the State similar to that of school districts.

R. L. Hargrove, attorney and general manager of the Madera Canal and Irrigation Company, declared that privately owned water companies are doomed to absorption by State fostered or controlled districts, as the former cannot successfully compete with the latter. This, he said, is due to the fact that many land owners in privately developed territory refuse to buy irrigation water, but pump cheaply from the water table which has been raised to a convenient height by the irrigation of adjacent tracts. The water companies are thus deprived of much of the revenue the territory would otherwise afford.

The next session of the conference is set for Nov. 29, when representatives of power and irrigation companies and reclamation and irrigation districts will be heard.

Neuces County Causeway Completed

The 8400-ft. Neuces County Causeway, which spans Neuces Bay, in Texas, connecting Neuces and San Patricio counties has recently been completed at a total cost of about $165,000. For a distance of 3600 ft. the structure is of reinforced-concrete with a roadway 19 ft. in width, flanked on the sides by 4-ft. concrete hand railings. For the rest of the length it consists of a riprap fill, with a driveway 40 ft. wide. In the fill the dredge worked through old oyster beds so that a large percentage of the material is pure oyster shell. The entire roadway will be paved with Tarvia. The causeway was designed by Bartlett & Ranney, consulting engineers, of Galveston and constructed by W. L. Pearson & Company, Inc., of Houston.

Texas to Establish Duty Station for Irrigation Tests

For the purpose of discovering, if possible, a more economic method of irrigation, a "duty station," to occupy a plot of 40 acres of land near Mercedes will be established by the State Board of Water Engineers of Texas, according to E. B. Gore, a member of the board. Different processes of irrigation will be tried out on the land and an effort will be made to obtain the best results with the most economical use of water. The establishment of the duty station is in accord with the co-operative work being conducted by the U. S. Department of Agriculture and the State board. While such stations have been established in connection with the rice industry, this will be the first station to be devoted to the study of duty measurements for general agriculture ever undertaken in Texas.

To Abandon Large Temporary Bridge in Indianapolis

The use of the large temporary bridge over the White River at East Washington Street, Indianapolis, that is at present used by car lines and heavy traffic, will soon be discontinued, as construction on the new West Washington Street bridge is rapidly nearing completion.

Cleveland Starts First Large Sewage Screen on New Development

The 14-ft. Riensch-Wurl sewage screens for handling 15,000,000 gal. per day in Cleveland were put into operation this week. This is the first large installation in this country and is located at the West Fifty-eighth Street plant, which will ultimately handle the flow from one-quarter of the area of the whole city, the site, the inflow and outfall lines all being planned for this service. At present the additional work at the station includes two of the ultimate six grit chambers and an outfall of 6-ft. diameter reinforced-concrete pipe, built on land in 18-ft. section, laid from scows and the flange joints bolted up by divers. Two features of the grit chambers, are the movable vanes by which the compartments may be varied in cross-section to get a constant 1-ft. velocity, and sand ejectors built under these compartments to remove the deposited sand hydraulically. R. Winthrop Pratt is consulting engineer in charge of the sewage treatment developments in Cleveland.

Work Started on Apraw Falls Electric Plant in Indiana

Work has been started on the new electric plant at Apraw Falls, south of Bicknell, Ind. The plant will cost approximately $1,000,000 to construct. The preliminary work, according to reports, is under the direct supervision of W. J. Stewart of the Stewart Electric Company, Cincinnati, Ohio. The company has purchased 2500 acres of coal land in the vicinity of Bicknell. On much of this land the coal is so close to the surface that mining is possible without the sinking of shafts. Large plants have been purchased by the company in Detroit and Philadelphia, and are to be dismantled and set up again on the site of the new establishment. A large dam, to be constructed across White River, is to furnish part of the power. The company already has signed contracts for the furnishing of power to all the larger surrounding cities. Work has also been started on a traction line to link Bicknell with Linton, Washington and Evansville, Ind. In addition to this, it is intended to run a line from Bicknell to the American, Indian Creek and Oliphant-Wasson coal mines, several of the large producers in the vicinity.

Construction to Be Started on $150,000 Bridge in Indianapolis

Construction will soon be started on a $150,000 bridge over Fall Creek at the intersection of Meridan Street, Indianapolis, to replace the bridge washed out in the 1913 floods. A temporary bridge is being erected at Pennsylvania Street to carry the traffic until the new structure is completed.

Sewage Disposal Plant Constructed at Y. M. C. A. Camp

A complete sewage disposal plant, consisting of an Imhoff tank, sprinkling filter and slow sand filters, has been constructed at the Y. M. C. A. camp at Altamont, N. Y. The works were designed by and constructed under the direction of Henry W. Taylor, consulting engineer of Albany, N. Y.

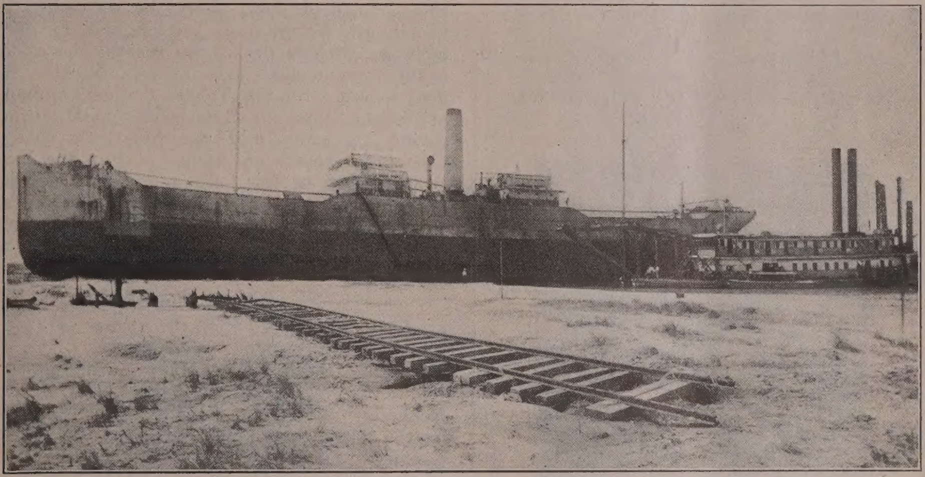
Illinois Highway Commission Refuses Aid in Oiled Road Project

The Illinois State Highway Commission has declined to give State aid in Champaign County's $40,000 oiled road project because the plans of the county board failed to provide for proper drainage in the improvement. A special meeting will be called to give the supervisors a chance to rectify the resolutions, which specified that none of the money should be spent in building culverts or bridges.

Large Wrecking Contract Completed in 44 Days at Galveston

A salvage contract involving the work of floating four stranded 2500-ton tramp steamers and a large schooner, by dredging to and around them and pulling them into the channels cut, was recently completed after forty-four days' work by the Bowers Southern Dredging Company at Galveston. The vessels went ashore in the Galveston hurricane last August. To release two of the steamers, the Eaton Hall and the Harlesden, which were cast up in the middle of the prairie at Swan Lake, a 4½-mile channel, 15 ft. deep and 200 ft. wide, was dredged. The Harlesden, the last of the five ships to be floated, was set free Nov. 1.

The Ribston, the first of the steamers to be released, went ashore at the railroad yards, and struck her nose across several tracks and into a turntable. A channel was dredged to and around her, and she was pulled into it stern first by tugs on Oct. 7. The other steamer, the Wallace, and the schooner, Edna V. Pickels, went ashore on Pellican Spit. The channel dredged to release them was in sand. After holes had been dredged around these vessels, powerful jets were used to wash out the sand directly beneath them until they could be pulled free.



DREDGE DIGGING OUT STEAMER THAT STORM LANDED IN RAILROAD YARD

It is said that the contract for floating the five vessels involved about $200,000. As soon as it was awarded, five dredges and 300 men set to work on the task of digging out the imprisoned ships. The dredges kept at it day and night, with few stops even for repairs, until the five vessels were afloat.

The long channel required to reach the two steamers stranded at Swan Lake was dug by two dredges, a large boat starting in from deep water and a shallow-draft dredge starting near the shore and digging to meet it. When the dredges met, both moved up to the head of the cut and attacked the remaining excavation side by side.

Royal Engineers Distinguishing Themselves in France

In a dispatch of Oct. 15 to the British War Office, Sir John French, commander of forces in France, commends most highly the courage and spirit of the Royal Engineers—the body in the British army corresponding to our Corps of Engineers and engineer companies. *The Engineer* of London, in its issue of Nov. 12, quotes the following paragraphs from the dispatch:

"I have on previous occasions called your Lordship's attention to the admirable work of the corps of the Royal Engineers. This work covers a very wide field, demanding a high standard of technical knowledge and skill, as well as unflagging energy; and throughout the supreme test of war these qualities have never been found wanting, thus reflecting the greatest credit on the organization of the corps as a whole, and on the training of the officers and men individually. The spirit which is imbued in all ranks from the base ports to the front trenches and beyond is the same. No matter where or how the personnel of the corps has been employed, devotion to duty and energy have been ever present.

"In this dispatch I wish particularly to draw attention to the work of the field units and army troops companies, which must almost invariably be performed under the most trying circumstances by night as well as by day. Demanding qualities of whole-hearted courage and self-sacrifice, combined with sound judgment and instant action, the work of officers, non-commissioned officers and men has been beyond all praise. The necessity for skilled labor at the front has been so continuous that Royal Engineer units have frequently been forced to forego those periods of rest which at times it has been possible to grant to other troops; but, in spite of this, they have responded loyally to every call on their services. Notwithstanding the heavy casualties sustained by all ranks, the esprit de corps of the Royal Engineers is such that the new material is at once animated by the same ideals and the same devotion to duty is maintained.

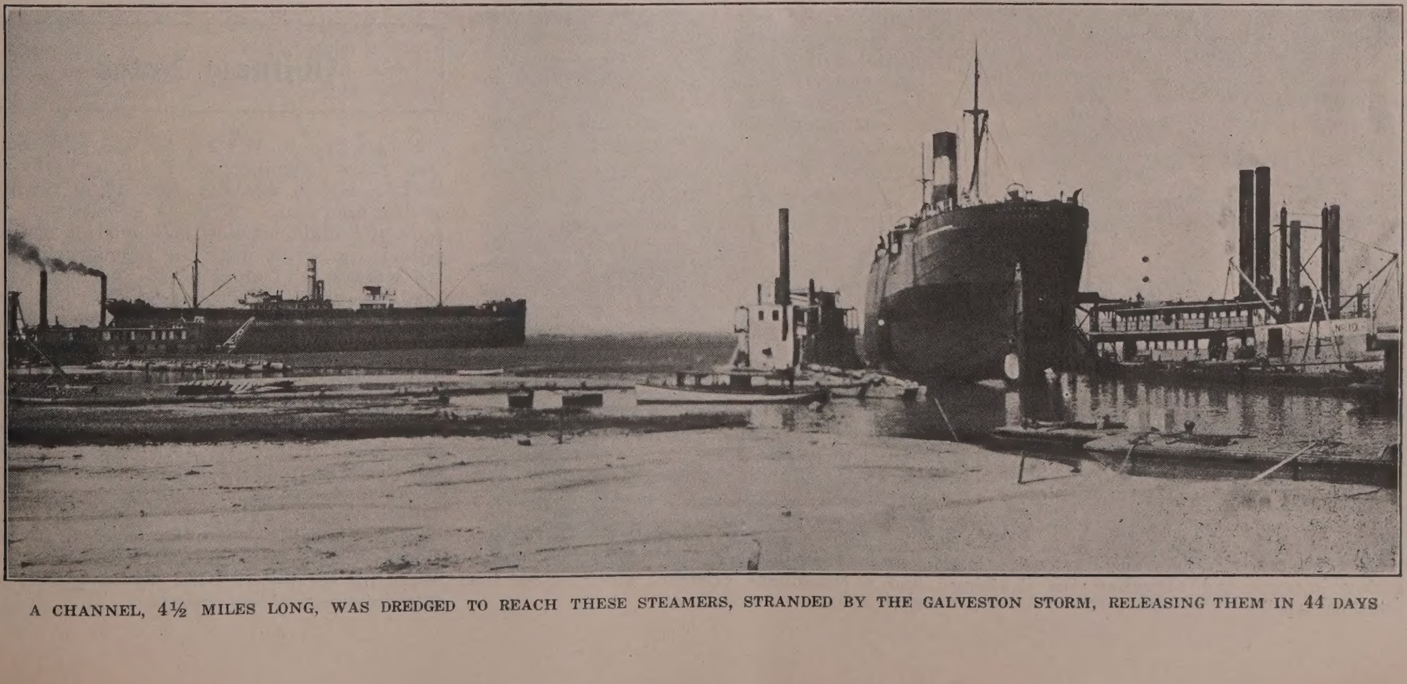
"I desire to call your Lordship's attention to the splendid work carried out by the tunneling companies. These companies, officered largely by mining engineers, and manned by professional miners, have devoted themselves whole-heartedly to the dangerous work of offensive and defensive mining, a task ever accompanied by great and unseen dangers. It is impossible within the limits of a dispatch to give any just idea of the work of these units, but it will be found, when their history comes to be written, that it will present a story of danger, of heroism and of difficulties surmounted worthy of the best traditions of the Royal Engineers, under whose general direction their work is carried out."

New California Highway Has Been Opened to Traffic

The Tejon Ridge Highway, a new trunk road connecting Los Angeles and Bakersfield, Cal., was formally opened to the public Nov. 16 after a period of rush construction in which special effort was made to have the roadway compacted and oiled before the winter rains set in. The road opens up an entirely new route between the two cities and will be 60 miles shorter than the Tehachapi Pass route and 35 miles shorter than the road via the Tejon Pass. The new route was described by N. D. Darlington, California State Highway Commissioner, in an article in Engineering Record, Sept. 11, page 322.

1192 Engineering Students Enrolled at the University of Illinois

The number of students registered in the College of Engineering of the University of Illinois up to Nov. 1 was 1192.



A CHANNEL, 4½ MILES LONG, WAS DREDGED TO REACH THESE STEAMERS, STRANDED BY THE GALVESTON STORM, RELEASING THEM IN 44 DAYS

News of Engineering Societies

The Lincoln Highway Association officers for the coming year elected at the meeting of the directors in Detroit, Nov. 10, are: President, Henry B. Joy; vice-president, Roy D. Chapin; treasurer, Emery W. Clark; secretary, Austin F. Bement.

The Engineering Society of Buffalo held a dinner at the Hotel Statler, Nov. 17, at which John Calder, president of the Metal Coating Company of America described a new spraying process by which, he stated, a non-corrosive surface can be put on iron and steel.

The Harvard Engineering Society of New York will hold its annual dinner at the Harvard Club in New York City, Dec. 11. The speakers will include F. A. Delano, vice-chairman of the Federal Reserve Board; Major-General Leonard Wood, U. S. A.; Prof. C. R. Mann, of the Carnegie Foundation, and Prof. George F. Swain.

The National Drainage Congress will be held at Cairo, Ill., Jan 19-21, 1916.

The Society of Constructors of Federal Buildings will hold its annual convention at Washington, D. C., Jan. 3-6, 1916. It is expected that President Wilson, Secretary McAdoo and Postmaster-General Burleson will address the convention.

Personal Notes

JAMES FORGIE, consulting engineer, of New York City, has been awarded a Telford Gold Medal by the Institution of Civil Engineers (British) in recognition of his paper on "The Laxaxalpam Aqueduct Tunnels in Mexico" and his engineering work in connection with that project. Among other Americans who have received this honor are: Col. W. H. Harts, William Barclay Parsons, W. J. Wilgus and J. V. Davies. Mr. Forgie was born and educated in Scotland, graduating from Gordon's College, Aberdeen, in 1885. From that year until 1899 he was a pupil of G. Gordon Jenkins, civil engineer. Later he served with Mr. Jenkins as resident engineer on the Insch Waterworks. From 1890 to 1892 he was engaged in railway work and, for the next three years was engaged in tunnel work, a good part of the time as chief assistant engineer on the construction of subaqueous and other tunnels of the Waterloo & City Railway, London. He also was consulting engineer on various other works of a similar nature. He came to the United States in 1902 as chief assistant engineer of the North River division of the Pennsylvania, New York & Long Island Railroad Company on the construction of the Pennsylvania Railroad tunnels under the Hudson River, New York City. He later served on the construction of the Hudson & Manhattan tunnels under the same river.

A. E. TRIPPLETT, formerly assistant superintendent of the Galveston, Harrisburg & San Antonio Railway, has been appointed division engineer of the Missouri, Kansas & Texas, at Parsons, Tex.

C. C. BROWN, editor of *Municipal Engineering*, will direct the courses at Purdue University formerly administered by Professor Sackett. A notice of Mr. Brown's connection with Purdue as published in these columns, Oct. 23, gave rise to some misunderstanding, so, to be clear on the matter, this journal wrote W. K. Hatt, professor of civil engineering at the university. In his reply Professor Hatt stated: "We are fortunate in having Mr. C. C. Brown as lecturer in sanitary engineering. He will direct the courses formerly administered by Professor Sackett and will be resident at the university one day each week, giving lectures and attending the drafting room periods."

LOGAN WALLER PAGE, director of the Office of Public Roads and Rural Engineering, has resigned as a director of the American Road Builders' Association, on account of the action of that organization in setting a convention for next February. Mr. Page believes that the Road Builders' action is in violation of the agreement made with the American Highway Association when it was decided to hold the Pan-American Road Congress in Oakland, and he feels compelled, therefore, to terminate his official connection with the Road Builders.

JOHN CLAYTON TRACY, formerly professor of structural engineering at Sheffield Scientific School, Yale University, has been promoted to succeed the late Prof. A. J. DuBois as head of the department of civil engineering. Professor Tracy was graduated from Sheffield Scientific School in 1890, and received the degree of Civil Engineer in 1892. During the year 1891-2, and in subsequent summers, he was engaged in bridge construction work. He was appointed an assistant on the Sheffield Scientific School faculty in 1892, instructor in 1894, and professor of structural engineering in 1915. During his period of twenty-three years at Yale Professor Tracy has devoted much time and thought to the study not only of the needs of his own department, but of the problems which have confronted other leading universities as well. He has also been active in the Yale Engineering Association, which was recently formed to promote the co-operation of the alumni in the development of the engineering courses at Yale. Professor Tracy is the author of the following works: "Introductory Course in Mechanical Drawing," "Plane Surveying," "Exercises in Surveying for Field and Office Work," and "Descriptive Geometry."

New Professor of Civil Engineering at Yale University

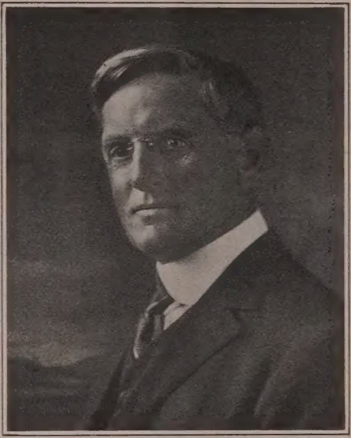


Photo. Yale Alumni Weekly

JOHN CLAYTON TRACY

B. S. STALEY, who has been engaged in contracting work for many years at Centerville, Iowa, has organized the B. S. Staley Supply Company in conjunction with William Kindig to engage in a general contracting business at Centerville.

BROWN & CLARKSON, civil and mining engineers, specializing in topographic engineering for city planning, reclamation and power development, of Washington, D. C., have moved their offices from the Star Building to the Oxford Building in that city.

ERNEST MCCULLOUGH, consulting engineer, of Chicago, has been elected second lieutenant in Battery B in that city, which has had a continuous existence since before the Civil War.

G. E. WRIGHT, formerly connected with the Poughkeepsie Engineering & Contracting Company on the construction of a dam and reservoir for G. F. McKinney at Crouses Store on Fishkill Creek, New York, is now with the New York State Public Service Commission, First District, on the construction of the East River tunnels from Whitehall Street to Montague Street, New York City.

CLIFFORD M. PRITCHARD, formerly designing and contracting engineer for the Oklahoma Iron Works, has opened offices in the Robinson Building, Tulsa, Okla., to engage in a general structural business, both designing and construction, particularly in connection with industrial plants where engineering is an important feature. Mr. Pritchard was graduated from Earlham College in 1893 and received a degree in civil engineering at the University of Michigan in 1902. His first work was as chainman and transitman on construction for the Norfolk & Western Railroad in the summer of 1892. Later he was with the Cincinnati, Hamilton & Dayton and, in 1897, he was awarded first prize for the design of a 120-ft.-span steel arch at LaSalle, Ill. He also served with the Toledo Bridge Company at Toledo, Ohio, the Gillette-Herzog Manufacturing Company and the American Bridge Company, mostly on design. For the past twelve years he has been engaged as designing and contracting engineer for the Kansas City Structural Steel Company, the Missouri Valley Bridge & Iron Company and the Oklahoma Iron Works.

PAUL L. REED, civil engineer, U. S. Navy, has been transferred from the Bureau of Yards & Docks, Navy Dept., Washington, D. C., to the Public Works Office, Navy Yard, Charleston, S. C. Mr. Reed was graduated from the Rensselaer Polytechnic Institute in 1894 and served from then until 1897 with the U. S. Coast & Geodetic Survey and the Chicago Bridge & Iron Company. In the latter year he went to Europe as technical assistant to Lindon W. Bates, designer and contractor for hydraulic dredging and dredges, and was, for 1½ years, stationed at Liege and Antwerp, Belgium, as his representative in charge of the construction of two large hydraulic dredges for the Russian Government. He also was representative and resident engineer on the construction of four sea-going suction dredges, for Australia and India, by Sir William G. Armstrong, Whitworth & Company at Newcastle-on-Tyne, England. He returned to this country in 1902 and, after serving for a short time with the Bucyrus Company of South Milwaukee, was appointed civil engineer, U. S. Navy, in which capacity he has served on various works in this country and the Philippine Islands.

Obituary Notes

FRANCIS G. WARD, for the past fourteen years commissioner of public works of Buffalo, died in that city, Nov. 16, at the age of fifty-nine years. With the exception of his work at Buffalo, his most notable achievements were in connection with the reconstruction of the wharves and plant of the Panama Railroad, for which he was general superintendent from 1885 to 1887, and in connection with the construction of the Turkish-Asiatic railways to Damascus and the Persian Gulf. His education was completed at *L'Ecole des Ponts et Chausses* in France, after which he was engaged from 1877 to 1885 in the transportation department of the New York Central & Hudson River Railroad. From this work he went to Panama and, from there he went to the Turkish-Asiatic Railway. Returning to the United States, in 1890, he engaged in the manufacturing business until 1896, when he began his service with the city of Buffalo as superintendent of waterworks.

WILLIAM L. CRAWFORD, who was for many years associated with the late Henry M. Flagler in the development of Florida and was for many years general manager of the Florida East Coast Railway, died in Garwood, N. J., Nov. 13, at the age of seventy-four.

C. C. WENTWORTH, principal assistant engineer of the Norfolk & Western Railway, died in Roanoke, Va., Nov. 11.

J. B. WILSON, a former city engineer of Walla Walla, Wash., died at Montour, Idaho, Nov. 13, at the age of sixty years.

Civil Service Examinations

Philadelphia.—Although the examinations for minor positions were mentioned in last week's issue, page 648, they have proved to be sufficiently important to enumerate separately. They are as follows, and are open to residents of Philadelphia who are over twenty-one years of age:

ASSISTANT ENGINEER, squad boss, department of city transit, salary from $2,000 to $2,200 a year. Applicants should have a technical school education and at least five years' experience in drafting, especially of structural design. The duties involve the supervision of a squad of draftsmen in the preparation of drawings for subway and elevated railway construction. Examination, Dec. 21 and 22.

ASSISTANT ENGINEER OF DESIGN, collectors and sewage disposal works, bureau of sewage, salary $3,000 a year. Applicant must have three years' experience in the charge of design and maintenance of sewage disposal works. The work requires designing sewage disposal works, including grit chambers, screens, tanks, percolating filters, disinfecting devices, and sludge-drying beds, and supervising their operation. Examination, Dec. 6 and 10.

ARCHITECTURAL DRAFTSMAN, department of city transit, salary from $1,500 to $1,800 a year. Applicant should have five years' practical experience in architectural design. This position like the first is in connection with subway and elevated railroad construction. Examination, Dec. 27 and 28.

DRAFTSMAN, department of city transit, salary from $1,200 to $1,500 a year. Applicants need three years' experience in drafting and must be familiar with steel and masonry construction. The duties relate to subway and elevated railroad construction. Examination will be held Dec. 29 and 30.

DRAFTSMAN, department of city transit, salary from $1,000 to $1,200 a year. Applicants must have one years' experience in drafting and a working knowledge of materials of construction. Duties involve making of preliminary and working drawings of subway and elevated railroad construction. Examination is to be held Jan. 4 and 5, 1916.

LABORATORY ASSISTANT, physical, Bureau of Surveys, salary from $900 to $1,000 a year. Applicants for this position must be graduates of a technical institution or must have had two years' experience in the practical testing of materials. The position relates to the assisting in the physical testing of cement, concrete, iron, steel, paving materials, building materials, etc. Examination, Jan. 4, 1916.

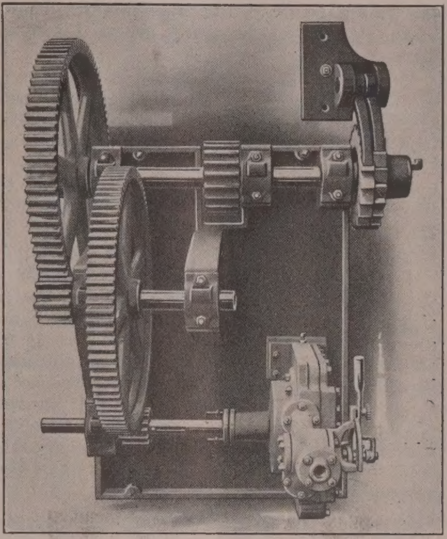
STRUCTURAL DRAFTSMAN, department of wharves, docks and ferries, salary from, $1,200 to $1,500. Applicant must have three years' experience in bridge and structural drafting, with a knowledge of pier design. In this position the duties will be to make designs, computations and drawings of structural steel work, pier foundations, bulkhead walls and other river and harbor improvements. Examination, Jan. 7 and 10, 1916.

ARCHITECTURAL DRAFTSMAN, salary from $900 to $1,200. Requires general knowledge of drafting and architectural design. The duties involve crayon work of elevations and perspectives of structures. Examination, Jan. 24 and 25, 1916.

There are, beside these examinations, examinations for pitometer operator, assistant draftsman, tracer and rodman, to be held Dec. 20, Dec. 20 and 31 and Jan. 6, 1916, respectively.

Compact Spud Hoist Eliminates Costly Equipment

Ease of operation, compactness and elimination of overhead rigging are features claimed for the Dake spud hoist which has recently been placed on the market. The machine, which is designed for raising and lowering spuds on dredges, is equipped with a reversing engine, which has no dead center and which will start, stop or reverse instantly.



EACH SPUD HAS A HOIST ALL ITS OWN

The hoist, as shown in the accompanying photograph, is bolted directly to the spud guides and its pinion meshes in turn with a rack on the spud. Being reversible, steam can be used for either picking up the spud or driving it down firmly. The hoist is manufactured by the Dake Engine Company, Grand Haven, Mich.

Mat System Lowers Cost of Concrete Forms and Strengthens Structure

Curved timber templets supporting flexible wooden mat-bearers upon which 26 gage sheet-metal mats are laid, as shown by the accompanying photographs, effect a saving which is claimed to vary from 3 to 5 cents per square foot over hollow-tile or metal domes. This form of joist construction for floors or roofs has been approved by the building department of the city of Cincinnati for 4-in. joists spaced up to 3 ft. on centers, while for the same total amount of steel and concrete, metal domes are allowed but 24 in. spacing.

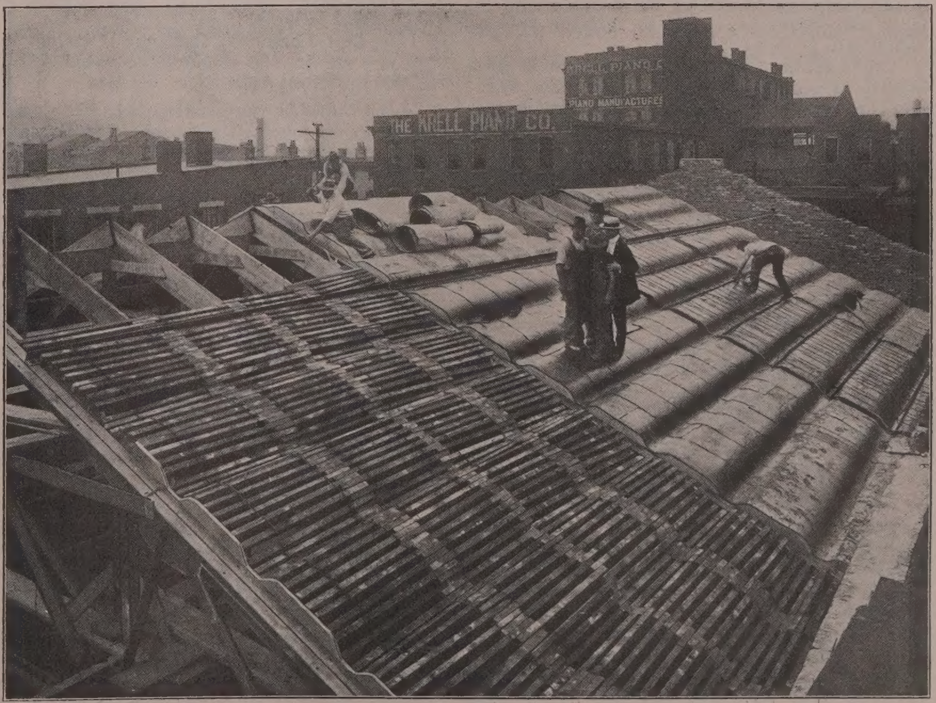
It is claimed for this type of adjustable forms that a stronger construction results for the same amount of materials, that the forms are stiffer, and that the triangle shape of the top flange of the concrete beams resulting from the use of the curving haunches increases the strength appreciably by increasing the depth to the center of compression concrete.

In the case of hollow tile, the saving is estimated at about two-thirds of the cost of the tile, but the tile construction has a bottom upon which to plaster, and in the case of plastered ceilings saves the cost of the metal lath. Even taking this fact into consideration, however, the net saving for this new construction is claimed to be the values above quoted.

Full information will be furnished by Edward O. Keator & Company, 2851 Melrose Avenue, Cincinnati, Ohio, sole agents for the Hodges system of adjustable forms for concrete work.

New Drill Rotation Saves Air and Reduces Moving Parts

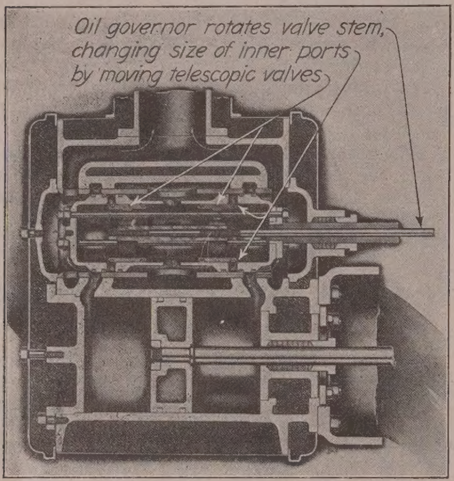
Air enters the rotation motor of the new hammer drill being made by the Chicago Pneumatic Tool Company first, and from there passes to the valve chamber of the main piston chamber. Thus the advantage of using one air supply for operating both piston and rotation is combined with that of having a separate motor for the rotation. This design eliminates ratchets and pawls and makes possible sturdy and compact construction of both the rotation and the main piston parts. The rotating motion is constant in one direction. It is secured by gearing a small, high-speed air motor, mounted on top of the drill, to a shaft, pinion and gear, which revolve the drill chuck. The top gear accomplishes the necessary speed reduction between the motor and the drill chuck by a worm thread on the motor shaft which meshes with a worm gear on the main shaft. A ball valve gear of simple and rugged construction is a feature of the design of the main drill cylinder. The drill, known as the "Hummer," is manufactured in 40, 55 and 65 lb. sizes, drilling ⅞, 1 and 1⅛-in. holes, 6, 8 and 12 ft. deep respectively.



MAT SYSTEM OF CONCRETE FORMS APPLIED TO ROOF CONSTRUCTION

Air Compressor Valve Is Designed for Super-Heated Steam

The balanced-piston steam valve gear shown in the accompanying cut has been developed to meet the increasing use of super-heated and high-pressure steam in air compressing. These factors are rendering the various forms of slide valve obsolete, as high temperatures warp such valves, causing leakage, and render them difficult to lubricate, causing excessive wear and loss of power. The cut-off valves illustrated herewith are right- and left-hand threaded to a cut-off valve stem, which is rotated by a speed and pressure regulator to vary the cut-off. This regulator is essentially a chain-driven rotary oil pump, which acts against a weighted plunger. The oil pressure maintained by this pump on the plunger varies with the speed of the compressor, thus changing the amount of steam admitted to the cylinder in accordance with the load. The regulation thus takes place in the valve chest, instead of outside the valve chest, as with an ordinary governor. Steam admission is through the center of the valve, the exhaust steam passing around the ends of the valve. It will be noted on studying the operation of the valve that practically all the packing is protected from high-pressure steam and exposed only to the exhaust steam.


Oil governor rotates valve stem,
changing size of inner ports
by moving telescopic valves

EFFICIENT VALVE FOR HIGH-PRESSURE STEAM

This method of regulation maintains a constant speed by changing the steam pressure, and also varies the speed to suit the rate at which air is being used.

The machines on which this valve is used are built with high and low pressure cylinders, connected by a "steam receiver," a special expansion joint being provided to guard against the tendency of temperature changes to throw the cylinders out of alignment. These compressors, called "Imperial" type XPV, are built by the Ingersoll-Rand Company of New York in capacities from 608 to 3620 cu. ft. per minute, and for discharge air pressures ranging from 10 to 110 lb. per square inch. In appearance and general design they are similar to the "Imperial" types now in service, having force-feed lubrication for the air and steam cylinders, closed frames, reciprocating parts with automatic lubrication by the bath system and completely water-jacketed air cylinders.

Business Notes

B. H. Rader, formerly eastern sales manager of the Universal Portland Cement Company and recently vice-president of the Hagar Portland Cement Company, has resigned to become western sales manager of the Lehigh Portland Cement Company, with headquarters in Chicago.

W. J. Johnson, manager of the Pittsburgh office of the Lidgerwood Manufacturing Company of New York City, will also have charge of the new offices that company has opened in the Widener Building, Philadelphia.

Robert E. Belknap has been appointed district sales manager of the Pennsylvania Steel Company and the Maryland Steel Company at New York City, succeeding R. W. Gillispie. The New York offices of the company are located in the Empire Building, 71 Broadway.

The Blaw Steel Construction Company sales engineers held their annual convention in Pittsburgh, Nov. 12-13. They met at the works at Hoboken, Pa., on the morning of Nov. 13 and viewed a number of new devices, after which they were entertained at luncheon in the dining room of the Blaw plant. In the evening a banquet was held at the Concordia Club.

Carl M. Bernegau, vice-president and treasurer of the Keuffel & Esser Company, manufacturer of drawing materials and mathematical and surveying instruments, of Hoboken, N. J., was the guest of honor at a dinner given by the firm, Nov. 16, in celebration of the twenty-fifth anniversary of his connection with the company. The dinner was attended by 500 employees.

J. P. Beck, formerly publicity manager of the Hagar Portland Cement Company, has resigned to undertake an extensive investigation along extension and publicity lines for the Association of Portland Cement Manufacturers. Mr. Beck is secretary of the Conference on Concrete Road Building and general manager of the Cement Products Exhibition Company which holds the Cement Show in Chicago. He was formerly publicity manager of the Universal Portland Cement Company.

Gustave Reinberg, vice-president of the McKiernan-Terry Drill Company, New York, following a ten-days' illness with pneumonia, died in New York, Nov. 22. He was widely known in the mining and contracting fields on account of his long association with companies selling to those classes. Years ago he was with the Forcite Powder Company and when that corporation was taken over by the DuPont interests Mr. Reinberg was for a time associated with the larger company. In 1891 he and S. J. McKiernan organized the McKiernan Drill Company, which in 1910, upon consolidation with the Terry Core Drill Company, became the McKiernan-Terry Drill Company. Mr. Reinberg was injured when his automobile ran off a ferryboat last January. On account of the exposure he had been in a weakened condition ever since.

Trade Publications

The following companies have recently issued trade literature:

Link-Belt Company, Chicago. Catalog 158, 8½ x 10¾ in., 38 pages, illustrated. Illustrates Link-Belt locomotive cranes.

A. D. Cook, Lawrenceburg, Ind. Catalog 12, 7 x 10 in., 68 pages, illustrated. Contains complete data on Cook's deep-well pumps and machinery.

Lansing Company, Lansing, Mich. Catalog 12C, 8¾ x 11¼ in., 36 pages, illustrated. Concrete batch mixers and numerous models of continuous mixers.

Foundation Company, New York. Catalog, 8 x 11 in., 32 pages, illustrated. Difficult underground construction in connection with bridges, buildings, dams, bulkheads and mine shafts.

Southwark Foundry & Machine Company, Philadelphia. Catalog, 8¼ x 11 in., 44 pages, illustrated. Describes in detail Southwark-Harris valveless engines, Diesel principle, stationary and marine types.

International Motor Company, New York. Booklet, 9 x 12 in., 40 pages, illustrated. An account of the performance of Mack armored trucks at the encampment at Plattsburg, N. Y., of the United States Army School of Instruction.

H. B. Sackett Screen & Chute Company, Chicago. Catalog 41, 6 x 9 in., 16 pages: illustrated. The design, construction and prices of various types of concrete spouting equipment are carefully described and illustrated in this booklet.

Ruggles Machine Company, Poultney, Vt. Catalog, 9 x 6 in., 96 pages, illustrated. A descriptive and ready reference book on Ruggles gas and gasoline engines, explaining the principles of heat engines, with instructions for their operation.

Weller Manufacturing Company, Chicago. Bulletins 28 and 29, 6 x 9 in., 4 pages each, illustrated. Describe one-man elevators for stone and ore-crushing plants and an automatic power shovel for handling cement, sand, ore, clay, etc., respectively.

Vulcan Process Company, Minneapolis. Catalog, 6 x 9 in., 12 pages, illustrated. Vulcan process of oxygen and hydrogen gas generation by electrolysis. Catalog, 6 x 9 in., 32 pages, illustrated. Vulcan process of oxy-acetylene welding and cutting of metals.

Southern Pine Association, New Orleans, La. Booklet, 9 x 11 in., 24 pages; illustrated. Opinions of civil engineers, paving experts, street commissioners and citizens' leagues on creosoted wood block pavements and tests of the United States Forest Service on shearing.

Mott Sand Blast Manufacturing Company, 1157 East 138th Street, New York City. Four bulletins, 6¾ x 8½ in., 4 pages each, illustrated. Direct-pressure sand-blast machine, sand-blast tumbling barrels, types P. V. S double and G., and sand-blast accessories for cleaning small grey iron, brass or aluminum castings are described in these bulletins.

Westinghouse Church Kerr & Company, New York City. Folder, 6 x 9 in., illustrated. Sets forth the merits of the new engine terminal of the Central Railroad of New Jersey at Communipaw, Jersey City, which was designed and built by this company in collaboration with the engineering staff of the railroad.

Simplex Concrete Piling Company, Tacony, Philadelphia. Catalog, 9 x 7½ in., 96 pages, cardboard cover, illustrated. This book presents concisely and logically the important features of Simplex piles and their various forms to meet ordinary and unusual conditions, and shows in clear reproductions tests made and many structures using these piles for foundations.

Sullivan Machinery Company, Chicago Bulletin 72, 6 x 9 in., 24 pages, illustrated. The edition dated August, 1915, describes in detail the Sullivan drill sharpener, a compressed air machine for forging and sharpening rock drill and hammer drill bits and forming shanks by hammering. The machine itself stands 6 ft. high over all and occupies a floor area of 5 x 2½ ft., weighing about two tons.

Carnegie Steel Company, Pittsburgh, Pa. Booklet on Bulb Sections; paper; 5 x 7½ in.; 16 pages, illustrated. Bulb angle sections suitable for both shipbuilding purposes and in steel railroad car construction. The shipbuilding bulb angles rolled to conform to British standards are included, and miscellaneous sections and bulb beams are described in the usual manner by diagrams and tables.

American Pulverizer Company, East St. Louis, Ill. Catalog 21, 3¾ x 9 in., 12 pages, illustrated. Describes ring and combined ring and hammer pulverizers for crushing brick, Portland cement, rock and the like. The descriptive matter accompanies the illustrations, other matter being in the nature of testimonials, explaining one or two instances of actual operation of pulverizers.

Mastic Bond Company, Inc., 18 East Forty-first Street, New York City. Folder, 8½ x 11 in., 4 pages. Deals with Par-Lock, a method of bonding plaster, stucco or cement finish permanently to structural surfaces. The process involves the application, by air pressure, of a mastic damp-proof bond into which a closely graduated crushed rock is driven, forming a rough surface which, when dry, engages the plaster finish. The process, it is claimed, produces a surface waterproof and free from cracks or stains at no greater cost than for a finish applied in the usual way. The weight of a Par-Lock ceiling is said to be only about one-third that of a ceiling plastered under the ordinary specification.